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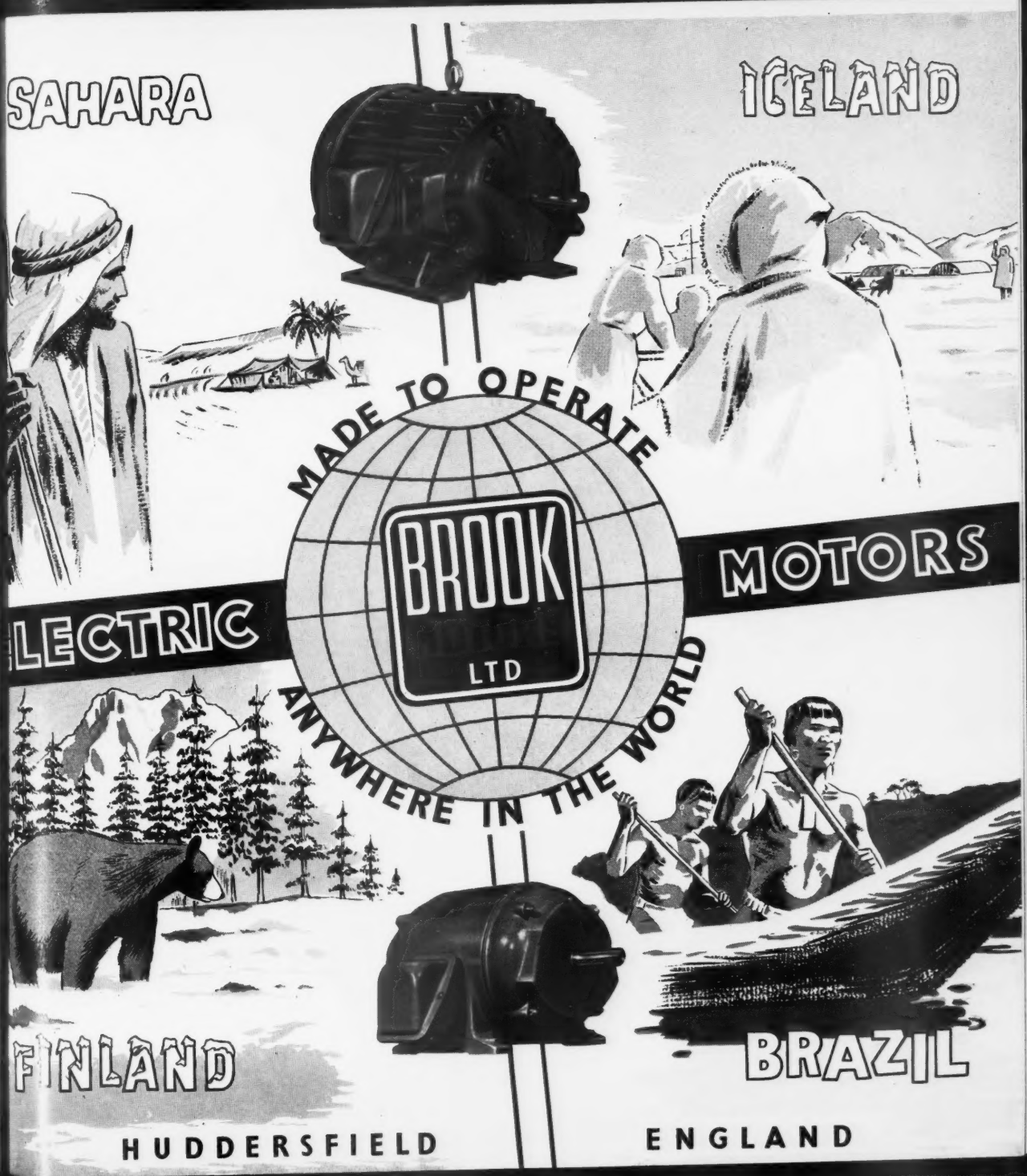
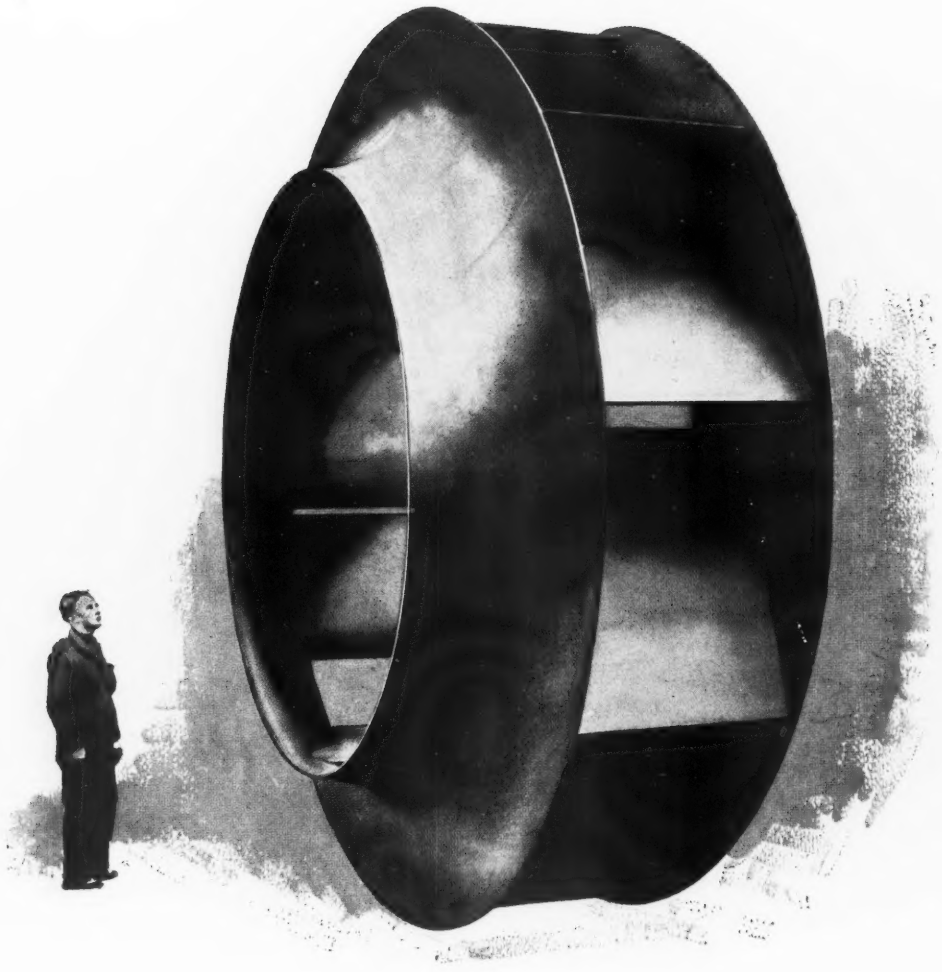
ELECTRICAL REVIEW

25 MAY 1956





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ELECTRICAL REVIEW

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25 MAY 1956

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The Convention Address

MOST of Sir John Dalton's presidential address to the British Electrical Power Convention at Torquay on Wednesday was devoted to the effects upon the electrical industry of the British Transport Commission's plan for the modernisation and re-equipment of British Railways. In point of fact Sir John showed that the effects will actually be very small—not because the plan is unimportant but because the electrical industry is of such great dimensions.

Had the Weir Committee's recommendations for complete main-line railway electrification been proceeded with just after 1931, when the Committee reported, the prospective increase in electricity consumption would have amounted to about 30 per cent of the national output. But so great has been the growth of electrical uses that by 1960 the proportion would have been only 3½ per cent and still less by 1971, when the present schemes are supposed to be completed. The result of this limited amount of electrification will be the addition of only 1 per cent to the national total by 1971.

The effect upon the manufacturing section of the electrical industry will similarly be quite small, albeit the plan will provide a useful addition to the manufacturers' order books. The expenditure upon the plan over fifteen years is put at £1,200 million, i.e., £80 million a year. This will not in any way embarrass the manufacturing industry which last year had an output valued at about £1,000 million. Exports alone accounted for £245 million according to the last B.E.A.M.A. report.

One interesting point introduced by the President related to these export figures. He pointed out that they covered only direct electrical exports and he contended that if the electrical equipment included in other classes of export was taken into account the electrical industry was the country's first, not second, exporting group. He also showed that the traction equipment export figure was not so satisfactory as it appeared. Most of it consisted of diesel-electric business; " pure " railway electrification equipment accounted for only 1 per cent of electrical exports. He attributed this to the absence in this country of electrified trunk lines which could be inspected by potential buyers from overseas and said that the completion of the plan would serve to remedy this.

Everybody in the industry will agree with Sir John's criticism of the Government's " economy " cuts in the Central Electricity Authority's plant programme which, as he showed, would not only upset the manufacturers' arrangements but also have adverse effects upon export trade.

AUTOMATION

It is in some ways a pity that the word " automation " was ever coined for it has given to many the impression that a new art has come overnight to sweep through industry to the discomfort of those on the shop floor. The report recently published by the Department of Scientific and Industrial Research on automation is aimed at a general audience and should help to clarify thought on a subject in which muddled thinking is rife. Automation is the coming together of techniques some of which represent logical developments in industrial mechanisation, moving forward during the last half century, and others which are of very recent origin. In analysing the streams of technical progress into three: mechanical handling and transfer, automatic control of machines or processes, and electronic computers, and concluding that automation occurs when two of these are combined together, the report has produced an excellent working basis for understanding the conception, and making use of the expression.

Time has shown that mechanisation in an expanding economy does not mean less employment but the reverse and automation as its successor should lead to better control of product quality, and reduced costs. Its application will necessarily be slow and in fact no true example of automation, as defined above, yet exists in this country. The D.S.I.R. report makes no mention of those industries such as coal, stevedoring and building where automatic methods are virtually impossible and old-fashioned physical labour is required. The effect on workers in such industries of extensive automation in others must not be overlooked.

FACING THE FUTURE

Some delegates at last week's conference of the Electrical Trades Union insisted that there should be no dismissals as a result of automation, but the majority were in favour of the Executive Committee's resolution calling for full consultation, payment of full wages until alternative employment was found, a shorter working week and longer holidays, training in the new techniques and higher wages from higher production. Some of these demands are reasonable, particularly that relating to consultation.

It is quite plain that automation hurried on without regard to the effects upon large numbers of people would be suicidal. Increased production is only feasible if there is a market for it. Wide unemployment would mean fewer buyers and less justification for a system designed to make more goods available or to make goods available more rapidly. It may be argued that the rate of introduction of automation cannot be such as to cause immediate alarm, but it will be wise to initiate at once a policy for meeting the very drastic changes which it will eventually bring about. Automation may be regarded as fundamentally desirable and the existence of arrangements for adjusting our economy to meet it will hasten its adoption.

PUMPED STORAGE

Some people regard pumped storage for electricity generation as an attempt to get something for nothing or to create a form of perpetual motion. We can see the reasoning behind this sceptical view because the amount of energy expended to elevate a certain amount of water to a required head must be, apart from working losses, equal to the amount of electrical energy which can be generated by that water at that head.

The answer to this question lies in the differences of the economics of operating a system between the time when it is generating, i.e., when the system is loaded, and when it is pumping, i.e., when the system is not loaded. The point is well expressed by Mr. A. R. Cooper in his article " Generation by Pumped Storage " in this issue when he says " in most cases appreciable savings can be made, both in capital expenditure and in the operating expenses of the system, as peak load kW obtained by pumped storage can be obtained at usually 60 per cent or less of the price paid for conventional steam generated kW." Whether the system load factor is improved by the pumping load is a moot point, however, because it is rather like counting the auxiliaries load of a station as consumers' load. Another useful point brought out by Mr. Cooper is the creation of an instantaneous power reserve against the failure of, say, a major transmission line. Indeed this could apply to any source of supply and represents a very considerable saving in capital expenditure.

The Convention President

Sir John Dalton, M.I.E.E., F.C.I.S., Barrister-at-Law, is chairman of W. T. Henley's Telegraph Works Co., Ltd., and associated companies, as well as being a director of other concerns. His connection with the electrical industry began in 1922 when he became legal adviser to the Electricity Commission, a position he held until 1927, then taking up the duties of director and general manager of the County of London Electric Supply Co., Ltd.; he was appointed a director of the London Power Co. and Central London Electricity, Ltd., in 1945.

During the last war Sir John (who was knighted in 1942) was Regional Controller of Fuel and Power for London and S.E. England, subsequently becoming chairman of the Public Utilities Coal Committee. After electricity supply was nationalised in 1948 Sir John left the industry and succeeded the late Sir Thomas Purves as chairman of the Cable Makers' Association. Leaving that post in 1953, he became chairman of the Henley Organisation.

He served with the R.E. Signals in the 1914–18 war and he was appointed hon. colonel of the Eastern Command Signals Regt., T.A., in 1941. He was responsible for the fifth edition of Will's " Electricity Law " and he has also produced treatises on the 1926 and 1947 Electricity Acts. He is a past-president of the Electrical Industries Benevolent Association, the Electrical Commercial Travellers' Association and the Fuel Luncheon Club.

John Dalton

Electricity and Transport

Sir John Dalton's B.E.P.C. Address

TORQUAY CONVENTION

The British Electrical Power Convention is now in progress at Torquay. It began on Wednesday with the opening of the Exhibition at Torre Abbey Meadows and Sir John Dalton delivered his presidential address on Thursday. Ten papers are being read and these, the discussions on them and other proceedings (with pictures) will be reported in next week's issue. The Convention ends next Tuesday with the annual general meeting.

IN the course of his address as President of the British Electrical Power Convention on Wednesday Sir John Dalton said that it was particularly apposite that, with the advice of the Council, he had chosen as the Convention theme "Electricity and Transport" so soon after the announcement of the adoption of high voltage 50 c/s a.c. as the standard railway electrification system. That important decision would present certain problems to the power supply engineer.

They were fortunate in having the description and effect of British Railways' Modernisation Plan dealt with by experts in six excellent papers. It was obvious that in the terms of the theme the application of electricity to road transport could not be excluded and it was dealt with in further papers. Only the question of time debarred them from having papers on electricity in ship propulsion and air transport. To the paper on "The Domestic Consumer" they were adding realism by demonstrating an electric house at the exhibition.

Sir John went on to say that public transport employed some 1½ million workers or some 6 per cent of the working population. British Railways, with which they were mainly concerned, were the largest employers with 577,000 people—40 per cent of the total. Excluding shipping, British Railways carried 63 per cent of the country's traffic and earned 25 per cent of the total revenue—£448 million. The railways had been operating under severe financial difficulties owing to their low load factors, out-of-date equipment and heavy capital charges.

Benefits of Railway Plan

Therefore the modernisation scheme was welcome; it was almost certain that the new capital investment would overcome the financial difficulties while the public would be given faster, regular and more frequent railway services. With freight traffic moving at express speeds there would be important beneficial reactions upon industry and possibly an alleviation of the congested heavy freight traffic on the roads.

Air pollution, estimated to cost the country £250 million a year, would be reduced. At present the annual consumption of coal by the railways was about 13 million tons—large coal of good quality. The Modernisation Plan would leave only 7,000 steam locomotives out of 19,000 which suggested that the railways would then require only 5 million tons of coal a year—a direct saving of 8 million tons by the substitution of electrification and diesel traction. But dieselisation meant imported oil and it also had to be remembered that the electrical industry used the lowest grade of coal.

It would be out of place to deal in detail with the plans for electrification. This was to be done by Mr. S. B. Warder in his paper. But, Sir John said, he would like to consider some implications of the estimated increased consumption of electricity by the British Transport Commission resulting from the Plan in fifteen years' time. That increase was put at about 1,500 million kWh and at first sight it appeared to be a useful addition to the national output, particularly as a considerable proportion of the consumption would occur at night, owing to the predominance of freight traffic.

Although this increase was not insignificant it was unlikely to have any material effect upon the national daily load curve. It should not be forgotten, however, that this was only the first instalment of true main-line electrification and the impetus it provided would bring much closer the general electrification of our main-line railways than was at present envisaged.

It was easy to say that if the Weir Report of 1931 had been acted upon the total electrification of all main-line railways would have cost only some £341 million as compared with the £1,200 million of the present scheme. But at that time conditions were unpropitious and put paid to any question of main-line electrification. Nevertheless, much was done between the two wars in extending suburban electrification.

Sir John exhibited curves showing the effect of the estimated new traction consumption on the total output of the Central Electricity Authority. In 1931, at the time of the Weir Report, the prospective total would have represented some 30 per cent of the annual electricity output; by 1960 this proportion would have been 3½ per cent and by 1971 probably 2½ per cent. On the same basis by 1971, as a result of the newly-announced electrification plans the proportion was likely to amount to only 1 per cent; it would have been 12½ per cent in 1931. It was obvious, therefore, that even if a considerable proportion of the demand was at night the effect on the national load curve was unlikely to be material.

Looking at the position in other countries, it was found that the highest proportion of traction consumption to total output was in Sweden where it was maintained at 9 per cent in 1939-49 in spite of the fact that the total consumption was nearly doubled in that period. Only in the United States and the Netherlands, in addition to Great Britain, did the traction percentage fall during the period. There was little doubt that at present the proportion of electricity consumed purely for traction purposes was probably lowest in Great Britain in comparison with most European countries. Sir John presented a table (reproduced herewith) comparing the prospective traction consumption with other loads and explained the bases on which he had produced the figures.

He went on to say that nothing of the foregoing was

intended to detract from the benefits to the supply industry which must result from the railways' Plan; the demand must favourably affect the national load factor and once electrification started it must go on developing. His main object was to show that the electrical industry could give every assistance to their transport colleagues whenever they decided, or were permitted, to extend their electrification plans.

Substantially, all the expenditure under the Plan would be in the form of wages. He worked it out that the annual expenditure of £80 million would provide employment for over 100,000 men of whom possibly half would be employed within the electrical industry.

The Weir Committee had referred to the ability of the electrical manufacturing industry to do the work because of its vast experience overseas. That applied even more so to-day for British electric traction equipment was of the best.

Export Trade

Turning to the export aspect, Sir John said that the electrical manufacturing industry claimed to be second only to the vehicles industry in export trade. His own view was that it was now the largest exporter because the figure taken related only to "direct" exports, i.e. it excluded the very large exports of plant and machinery which contained electrical gear and cables, the value of which could not be assessed. In any case there was every reason to suppose that within the next year the official trade returns would show this country's electrical manufactures as constituting the largest export group in the United Kingdom; the industry was only fifth in 1939. The proportion of electrical exports to the total had risen from 4·3 to 8·4 per cent.

Curves were shown which indicated that the bulk of the increase in traction equipment exports was due to higher diesel-electric business and Sir John claimed that they demonstrated that no real progress had been made in the development of exports of equipment for "pure" electric drive for railway purposes. Apart from diesel-electric exports less than 1 per cent of electrical export business was accounted for by traction items. He believed this to be due in part to the fact that we had been unable to show overseas visitors effective trunk line electrification schemes here. The Transport Commission's Plan was therefore to be welcomed by the electrical manufacturing industry as it provided at last the possibility of our having an effective international "showcase."

One of the main reasons for the satisfactory growth of electrical exports was the excellent collaboration between the manufacturers and the Central Electricity Authority and Area Boards. Officials of these bodies were always willing to help manufacturers to show foreign visitors who were potential buyers not only the equipment itself but also the operational methods adopted so effectively in this country. He looked forward to similar close co-operation with their transport colleagues when they were ready to demonstrate the success of the electrification plan.

Sir John then gave some attention to electricity in ship propulsion and said that the steam-electric drive was now well established and offered decided advantages over the steam-mechanical system. The diesel-electric system of drive had also proved its suitability for small and medium vessels and for certain special applications, e.g. ice-breakers and tugboats. The use of a.c. for auxiliaries was now established and would probably be used in large passenger liners. Where d.c. was still necessary it was likely that germanium rectifiers would be used.

Referring to electricity in aircraft, the President said that in some civil machines cabling alone was becoming a major problem. In the new Bristol aircraft the total weight used was about one ton (30-35 miles of wire). At airports electricity was used extensively; at London Airport, for instance, there was a supply transformer capacity of 20 MVA and the demand to date was 6 MVA; there was an excellent load factor of 74 per cent.

Disorganising Effect of Restrictions

Sir John then turned to the restrictions on capital investment which, although placed primarily on the C.E.A., must be reflected on the whole economy of the electrical industry. The normal 1956-57 programme of the C.E.A. and Area Boards called for an investment of £213 million; the C.E.A. had submitted a programme involving £204 million but the Government finally approved only £195 million. The effect would be that the capacity of the plant to be commissioned in 1958 and 1959 would be reduced by some 500 MW. From the manufacturers' point of view this interference with balanced and carefully phased programmes must result in a loss of impetus and rhythm and the postponement of delivery dates for large orders must to some extent disorganise production in the shops.

The restriction must also have a serious effect on the distribution programmes of the Area Boards, preventing them from catching up on arrears and coping with new demands. After reviewing the serious effects on the continuity of supply at peak periods, Sir John mentioned the new borrowing arrangements for the nationalised industries which, he said, would enable the Government, if it wished, to strengthen its control over the investment programme of the C.E.A. If this were so it was to be deplored. It also meant that the Authority would have to provide more funds from internal savings which, in turn, meant that the consumer would pay more for his electricity.

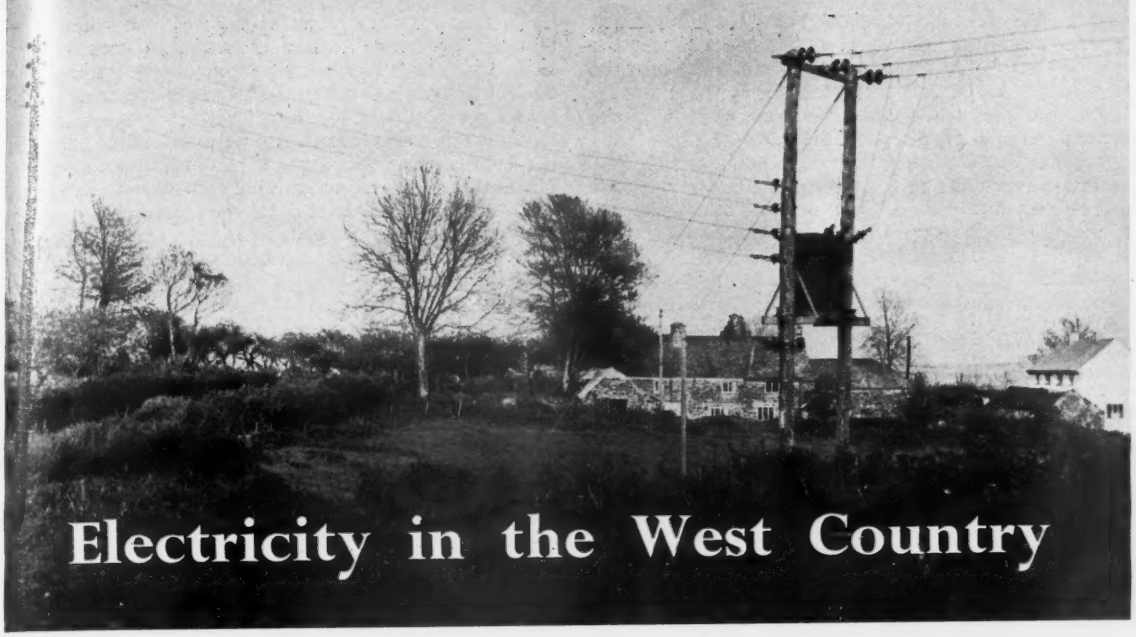
The restrictions would also have a frustrating influence upon exports. It was fallacious to think that when manufacture was restricted at home we should be able to sell more overseas. Already the industry was fully extended in markets which were full of hazards.

The railway electrification plan did not render nugatory the effects of these restrictions on capital investment. The work, which would fall on a comparatively small section of the industry, could be absorbed quite comfortably.

In conclusion Sir John said he was sure that the industry was wholeheartedly behind the Chancellor of the Exchequer in his crusade to halt inflation and achieve an increase in personal savings. He was also sure that any setback from the present credit restraint must only be temporary. Given restraint in non-productive expenditure, especially by the Government, and some alleviation of the "cold war" tension the great electrical industry could make one of the greatest contributions to the future prosperity of the country.

Atomic Power in the South West

ADDRESSING members of the Bristol Rotary Club on 14th May, Mr. A. C. Thirtle, controller of the South Western Division of the Central Electricity Authority, said that as nuclear stations would only provide a fraction of the number of new power stations required in the next decade or so, it was preferable not to use sites which were suitable for large stations of orthodox type. Work on the Berkeley site should commence about the middle of 1957 and the station would be ready for initial operation by the end of 1960. After recalling that there had been objections to the Bradwell scheme, Mr. Thirtle said that the Berkeley project had been generally accepted and there was hope that final planning permission would be obtained in the near future.



Electricity in the West Country

Progress Since Last Torquay Convention

By H. D. B. WOOD, O.B.E.*

BARELY three years have passed since we in South Western Electricity last welcomed the B.E.P.C. to Torquay —too short a time to inflict again on the readers of the *Electrical Review* the sort of abridged Baedeker-cum-Garcke article, depicting the electrical and other amenities of the Area, which has come to be associated with the special Convention numbers. Instead I shall try to show what progress we in this Area have made in this short interval in our efforts to overcome the problems which characterise electricity supply in the West Country. By a happy chance the official business of these two Conventions provides a convenient thread on which to string this article; so I shall start with rural development, where the '53 Convention left off, and end with the domestic load, where this year's Convention takes up.

The emphasis of the 1953 paper on rural development delivered by Mr. S. F. Steward (then chairman of the South Western Electricity Board) was that nationalisation both created the need for a new approach to this age-long problem and also provided the means for a broader and systematic attack on a matter which assumed even greater importance in view of the drive to raise agricultural productivity in the interest of the national economy. He pointed out that from the point of view of supply economics the problem was becoming more intractable as supplies had now to be taken out to the really isolated communities and to the outlying farmsteads and that nowhere was the problem more acute than in the South West, with its small hamlets and farms spread out over the whole of the countryside. On the other hand it was these country dwellers, denied so many other amenities of present-day life, who so urgently needed electricity to help them on the farm and in the home and to stem the ever-increasing drift from the land.

From the discussion which followed it was evident that there was a wide and growing realisation in the industry that the time had come to replace piecemeal development by a broader national programme, and for the economics of the job to be seen as a whole against the Boards' statutory and social obligations.

The plan and the philosophy behind it, out of which emerged the industry's national programme published by the Central Authority and the Area Boards in April, 1954, were appropriately enough worked out at Moretonhampstead. We in the South West had the toughest assignment, measured both in terms of what needed to be done and the wherewithal to finance it. At that stage fewer than half the farms in the Area had a supply, despite rapid progress since vesting day, and the cost, at the prices then ruling, of taking supplies to the accessible remainder was estimated at over £14 million. Sustained by the knowledge that the rest of the industry recognised the magnitude of this task in relation to our resources and would stand by us if, despite our determination to carry it alone, the burden

* Mr. Wood is Secretary of the South Western Electricity Board.

Title picture shows an example of rural supply: Hartshole Farm, Tavistock

In 1951 there were only eighteen grain dryers in use in the South Western Area; there are now over two hundred

proved in the event too heavy, we were able to make new plans for the future and we set as our target for the five years 1953-1958 the connection of a minimum of 5,000 farms and 24,000 other rural premises. By the end of the third year at March last we had connected 3,757 farms and 24,284 other rural premises and, the " credit squeeze " notwithstanding, we have high hopes of completing the programme in four years instead of five. In this way we have been able after only three years' working to cut one year off the fifteen-year period previously forecast for completing the rural electrification of the Area.

How has this acceleration been achieved? Without doubt this rate of progress is the result of superseding piecemeal methods by a broader system of planned development. Instead of seeking a separate economic justification of each scheme undertaken, we worked out the total cost of the five-year phase—" pooled the cost " in other words—and spread the extra charges as fairly as possible over all the consumers to benefit. The old individual line rentals, which resulted inevitably in partial development by requiring very high charges from those whose premises lay furthest from the projected route of new mains, were replaced by standard rural development contributions (R.D.C.). This is essentially a community system in which all prospective rural consumers pay alike according to the type of premises to be supplied.

Part of the interior of the Exeter Service Centre opened last month

A "brides" class in progress at the Plymouth Service Centre, one of a series held in the major centres

While this new approach was welcomed at the outset by the Consultative Council and the County Branches of the National Farmers' Union, it is only now that we can really see its benefits in improving the economics of rural supplies. Previously, when the supplementary rural charge had to be related to the cost of each scheme, we considered ourselves lucky if about half the prospective consumers agreed to come in at the start. Now on R.D.C. terms nearly 85 per cent of all the premises come on when the mains go up and nine out of ten farms take the supply from the start, thus reducing the average cost of connection and ensuring a quicker build-up of revenue. Perhaps even more significant, each farm, house or cottage is now making on average a better contribution to the excess and rising cost of providing these isolated supplies.

The re-imposition by the Government of capital restrictions has inevitably caused some slowing down, but we are doing all we can to keep up the rate of rural connections by redoubling our efforts to bring on supply premises which are relatively close to mains erected in earlier years.

Rapid Load Increase

What of the Area economy and its ability to support this rising tempo of rural development, to pay the charges for interest and depreciation on the new networks and the cost of planning and negotiating rural schemes—in itself a very costly business? Here again the three years from Torquay '53 have shown a striking change. We have moved out of the " red " and all that it implied into the " black " with trading surpluses which, if not a true guide to enterprise and managerial efficiency, at least carry with them an air of respectability in the eyes of our more fortunately placed colleagues.

Fundamental to this strengthening of our trading position is the rapid build-up of load. Total energy sold rose by 10 per cent in 1953-54, 20 per cent in 1954-55 and again by 13 per cent in 1955-56, representing an overall improvement of 48 per cent in three years, substantially the most rapid increase anywhere in the country. In an Area naturally deficient of industry every attempt has been made to secure the industrial load by a promotional tariff system and by service to industrialists and, as the tables show, the results are encouraging. With the change in industrial location as a result of labour shortages and the application of electricity to an ever-increasing range of industrial processes this progress should go on; certainly as a Board we shall leave no stone unturned in an endeavour to strengthen what must otherwise be a weak spot in the economics of West Country electricity supply.

The rise in commercial sales is hardly less satisfactory and the value of a buoyant commercial demand in this Area, one of the foremost holiday regions in the country, needs no emphasising. There are great opportunities for gaining more of the catering load where high wages and shortage of skilled staff are tending to work more and more in favour of electricity. Special exhibitions of catering equipment held recently in Bristol and Newquay have shown the very live interest which exists among caterers for all the lighter forms of equipment which save labour and extend the range of facilities afforded to guests, and the response of the trade to the special 1½d/kWh rate introduced very recently by the Board for separately metered cooking and water heating points to the need for a simple and adaptable tariff as an indispensable means of securing the installation of cookers and water heaters on

any scale. Assessment of hotel bedrooms on an installed capacity basis is an irritant and an obstacle to the good relations which we must have with the hoteliers and we hope very shortly to remedy this.

The development of agricultural sales is an uphill business and the marked improvement in average farm consumption shown in the tables would be more reassuring if the increase in the use for agricultural purposes was more commensurate with the improvement in the use for domestic purposes in the farmhouses. It needs to be recognised, however, that the small stock-raising farms of the South West do not offer the same scope as the bigger mixed dairy/arable farms up-country.

Domestic Electrification Activities

This brings me to the domestic load, the subject of the paper to be given by Mr. Bellamy at this Convention. No Board is quite so dependent as South Western Electricity on the domestic load: about 42 per cent of our total revenue is derived from this source alone compared with the national average of 33 per cent. A relatively higher proportion of our new capital investment is concerned with supplies to the ordinary householder and the implications of this and the need for a vigorous development policy may be seen from the single fact that in the eight years since vesting day we have had to provide mains, meters and services for over 160,000 new domestic consumers compared with the 437,000 on supply at 1st April, 1948.

The problem of securing an improvement in the domestic load commensurate with the rising cost of maintaining these supplies is complicated by the fact that nearly half our total domestic consumers are concentrated in the two cities of Bristol and Plymouth where not only was the average consumption abnormally low, but the showrooms and other premises needed for a commercial expansion had been completely destroyed in air raids.

Since 1953 domestic development activities have been steadily expanded and the degree of progress made can be judged by the increase in the turnover of sales of appliances which has been more than doubled, from £830,000 to £1,882,000, and the rise in the average consumption per domestic consumer from 1,300 to 1,550 kWh. This improvement has occurred notwithstanding the unprecedented acceleration in the housing programme and in the number of new consumers coming on supply for the first time. These domestic development activities have been devised with a double aim: first, of course, to bring about a substantial improvement in the system load factor which tends to be low on account of the unfavourable load characteristics of the Area; secondly, to build up the profitability of our appliance merchandising so that this ancillary activity, in addition to improving the load, would in itself help towards meeting the high cost of providing an efficient electricity service to consumers everywhere throughout this large and predominantly rural Area.

Introduction to electric cooking at the Plymouth Service Centre

Thermal storage heaters mounted on a wall of John Harvey & Sons' wine cellars in Bristol. Over 2,600 kW of such heaters has been installed

Increase in Electricity Sold

Class	Year ended 31.3.53 (million kWh)	Year ended 31.3.56 (million kWh)	Increase %
Domestic	701·5	929·1	32·4
Farm	46·8	75·1	60·5
Commercial	310·3	480·8	54·9
Industrial	507·2	842·5	66·1

Rise in Average Consumption

Class	Year ended 31.3.53 (kWh)	Year ended 31.3.56 (kWh)	Increase %
Domestic	1,303	1,554	19·3
Farm	3,996	4,897	22·5
Commercial	4,534	6,360	40·3
Industrial	73,850	123,898	67·8

Our sales programme is, therefore, a three-point plan: to connect as many water heaters as possible, to maintain a steady growth in cooker business and, at the same time, to ensure that the Board gets its rightful share of the present market for such popular appliances as refrigerators, cleaners and washing machines. In the financial year just ended we put out over 30,000 water heaters (compared with 3,813 in 1952-53); we also raised cooker sales to a record level and, at the same time, more of the other major appliances were sold than ever before. The profit from these selling activities will accordingly be substantially higher than last year.

Although the three years covered by this article are really too short a period in which to draw any firm conclusions on the trend in load factor, it is nevertheless significant that this was 4 per cent higher last year than in 1953, a good augury for our future and an encouraging sidelight on Mr. Bellamy's paper.

New Books

Basic Processes of Gaseous Electronics. By L. B. Loeb. Pp. 985; figs. Cambridge University Press, 200, Euston Road, London, N.W.1. Price £5.

Professor Loeb is well known to all workers in the field of gaseous discharges, both as the director of a large and influential school of research and for his earlier books, "The Kinetic Theory of Gases" and "Fundamental Processes of Electrical Discharges in Gases." The latter appeared in 1939 and soon created a name for itself as a careful, critical account of the whole field based on the best available experimental data. The book under review is designed to replace the 1939 volume, a step which is necessary mainly because of the rapid advance in experimental technique which took place in the war years. The precise measurement of short time intervals and the ready availability of microwave valves capable of generating useful amounts of power have revolutionised the field.

On the other hand, theory has not stood still and problems such as breakdown at high frequencies, recombination and the exact energy distribution observed under various conditions are largely solved. Thus, the new "Loeb" adheres closely to the plan of the old one but the material included is largely new, the exceptions being, naturally, the more basic and elementary part of the subject. Also, Professor Loeb has had the assistance of leading workers from other schools, especially those at the Massachusetts Institute of Technology and at the Bell Telephone Laboratories, who have contributed sections on their special subjects. These include S. C. Brown on microwave studies and G. H. Wannier, J. P. Molnar and J. A. Hornbeck on the B.T.L. studies.

It will be clear from what has been said already that this book is indispensable to any serious research worker in this field. As Professor Loeb points out, gas discharge physics has suffered very much from the attention of peripatetic researchers on the look-out for quick results without too much hard work. These gentlemen had often brought in question the results of better qualified workers. His book should leave little excuse for exercises of this sort, because it makes it so easy to determine the state of our knowledge, as at 1955.

Professor Loeb is probably at his best in describing experimental work. His accounts of theoretical work seem more complicated than they need be merely because he does not take sufficient care in defining the physical model and situation which the mathematics is intended to describe. In the more advanced developments the derivations are sometimes so sketchy that it would have been better to have cited a result, referring the reader to the original. Of course, the references are included and form a most important feature of the book. However, this is not intended as a textbook, even at a very advanced level, so this criticism is a minor one.

Professor Loeb has added to the debt owed to him and his school by all researchers in this fascinating subject, so closely bound up with the original development of "modern" physics in this country, under the great J. J. Thomson.—A.H.B.

Instruments for Measurement and Control. By Werner G. Holzbock. Pp. 371; figs. 216. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 80s.

According to the preface this book has a threefold objective: "to acquaint the reader with the types of instruments available for the measurement and control of process variables; to be a reference book for those who are searching for an instrument that fills their specific needs; to give the man who develops new instruments an opportunity to compare some of the approaches used by his colleagues in the solution of problems common to the instrument industry." The first two objectives have a great deal in common. In trying to meet them the author has obviously surveyed a very broad field, but as far as the British reader is concerned the objectives fall short, since all descriptions refer to instruments of American manufacture, albeit a few are of British design origin. It is doubtful, too, whether the third objective is reached, as such a wide coverage could not contain sufficient detail to serve this purpose, e.g., the subject of pH is dealt with in less than two pages, and thermal conductivity measurement in less than a page of text.

The book can be described as a thesaurus of American instrument makers' catalogue information, and in this respect there is a suspicion that a few of the statements have been inspired by extravagant claims made in some manufacturers' sales literature. The first nine chapters describe typical instruments for the measurement of flow level temperature, etc., including one chapter devoted to analytical instruments. The author should be commended for the inclusion of some of the latest American developments such as mass flow meters, and electric magnetic flow meters. The five subsequent chapters are concerned with automatic control and again the text is well up-to-date with details of some of the modern American electronic control units.

The terms and definitions used throughout the book are based on the recommendations of the terminology committee of the Instrument and Regulators Division of the American Society of Mechanical Engineers, and these are not in accordance with the now well accepted terms used in this country as given in B.S. 1523.

Although a number of criticisms could be levelled at this book, it can be recommended for its readability, simple style, and large number of excellent illustrations. Anyone wishing to become familiar with current designs of American instruments will find this book a most interesting one to read.—R.S.M.

BOOKS RECEIVED

A.C. Generators and Motors. By Philip Kemp, M.Sc.Tech., M.I.E.E., and W. H. Date, B.Sc.(Eng.), M.I.E.E. Pp. 51; figs. Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 6s. 6d.

Magnetic Recording Handbook. By R. E. B. Hickman, M.B.K.S., M.T.S. Pp. 176; figs. George Newnes, Ltd. Price 21s.

Intermediate Electrical Theory. By H. W. Heckstall-Smith, M.A. Revised edition. Pp. 679; figs. J. M. Dent & Sons, Ltd., Aldine House, 10-13, Bedford Street, London, W.C.2. Price 18s. 6d.

Electrical Interference. By A. P. Hale, Graduate I.E.E. Pp. 122; figs. Heywood & Co., Ltd., Tower House, Southampton Street, London, W.C.2. Price 15s.

Strength and Elasticity of Materials. By W. H. Brooks, Ph.D.(Eng.), B.Sc.(Eng.). Volume IV—Solutions to Examination Questions B.Sc.(Engineering)—Part Two (External). Pp. 464; figs. MacDonald & Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 35s.

Peaceful Uses of Atomic Energy. Proceedings of the International Conference in Geneva, August, 1955. Vol. 2, Physics, Research Reactors. Pp. 471; figs. H.M. Stationery Office, P.O. Box 569, London, S.E.1. Price 57s.

Factory Electrification. By F. T. Bartho, Associate I.E.E., M.Inst.W., and C. H. Pike, A.M.I.E.E. Pp. 398; figs. MacDonald & Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 35s.

Higher National Certificate Workshop Technology. By T. Nuttall, A.M.I.Mech.E., A.M.I.P.E. Pp. 551; figs. (Technical College Series). English Universities Press, Ltd. Price 30s.

Methods in Numerical Analysis. By Kaj L. Nielsen, Ph.D. Pp. 382; tables. The Macmillan Co., 10, South Audley Street, London, W.1. Price 48s 6d.

Generation by Pumped Storage

General Principles and Survey of Modern Schemes

By A. R. COOPER, M.Eng., M.I.E.E., M.Inst.F.*

ONE of the oldest pumped storage plants of any magnitude is the Herdecke station in Northern Germany, which has a generating capacity of 140 MW, and was commissioned by the Rheinisch-Westfälisches Elektrizitätswerk A.G. at the beginning of 1930. This scheme was designed to carry the peak loads of the network belonging to the R.W.E. and to maintain the output of the base load stations as constant as possible. It was also intended to provide an instantaneous power reserve so that in the event of the failure of any major transmission line, it would be in a position to supply large blocks of energy in the shortest possible time. These two main functions, namely, improving the load factor on generating plant and providing a reserve of potential energy which can be quickly released into the network, are the principal reasons for installing pumped storage schemes.

Economics of the System

The desirability of increasing the night load so as to improve the system load factor, together with the need for providing large blocks of standby potential energy, has made the pumped storage scheme increasingly popular, and the table below lists some of the major pumped storage schemes which have been brought into service since 1925.

The economics of a scheme need to be carefully worked out before pumped storage is adopted, but in most cases appreciable savings can be made, both in capital expenditure and in the operating expenses of the system, as peak load kW obtained by pumped storage can be obtained at usually 60 per cent or less of the price paid for conventional steam generated kW, whilst the reduction in banking losses on standby steam plant can make a considerable contribution towards the economic operation of the system. The economic merits of pumped storage are greatly enhanced if there is a marked difference between the costs of generation of the peak load plant and the base load plant, which will supply the energy for pumping.

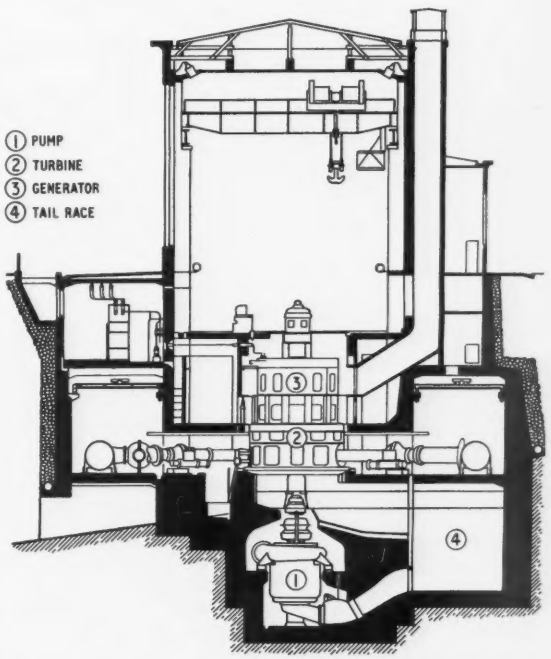


Fig. 1.—Cross-section of a typical pumped storage plant (Altendorf power station of the Etzel hydro-electric scheme)

A pumped storage scheme consists essentially of an upper and a lower reservoir which are connected by pipe lines. Plant units which can operate as hydro-generators or as electrically-driven pumps are connected into the pipe lines at a station adjacent to the lower reservoir. A typical pumped storage plant unit is shown in Fig. 1. It consists of a motor, which can also operate as a generator, which is directly coupled to a hydraulic turbine. Below this assembly is a coupling which can connect and disconnect a pump. During pumping, energy from the supply mains operates the motor, the hydro-turbine is left out of commission, the coupling is locked in and the motor drives the pump direct and delivers water from the lower reservoir to the upper one. This pumping usually takes place for a period of about six hours during the night. For peak load operation the coupling is disconnected from the pump, water is allowed to flow down from the upper reservoir through the turbines to the lower reservoir and the turbine drives the generator which exports electricity into the supply system.

There are several constructional variations on this theme, but the broad principles of operation remain the same.

DETAILS OF MAJOR PUMPED STORAGE SCHEMES

Date[1]	Station	Country	Generating Capacity MW	Pumping Capacity MW	Pump Head ft
1925	Rempen	Switzerland	4×16	4×5	804/853
1926	Tremorgio	Switzerland	1×10	2×5	3020
1929	Niederwartha	Germany	4×22	4×20	455/506
1930	Herdecke	Germany	4×35	3×27	485/550
1930	Rocky River[2]	U.S.A.	1×25	2×6·5	200/240
1932	Bringhausen	Germany	4×35	4×22	945/1010
1932	Bleiloch	Germany	4×20	1×18 1×12	92/135 88/164
1932	Hausern	Germany	4×33	4×20	690/785
1932	Zappello	Italy	2×5·5	4×2	984/1260
1933	Sillre	Sweden	2×7	2×6·5	600/730
1934	Lac Noir	France	4×30	1×13 3×20	295/427
1943	Witznau	Germany	4×53	4×32	825/900
1946	Etzel	Switzerland	8×16	2×16	1400/1580
1949	Provvidenza	Italy	3×50	2×45	790/950
1950	Cotilia	Italy	2×33	2×30	400/505
1950	Waldshut	Germany	4×43	4×18	540
1951	Buchanan Dam	U.S.A.	1×12	1×10	120/132
1951	Grand Coulee[3]	U.S.A.	—	6×45	300
1954	Flat Iron[4]	U.S.A.	2×35 1×10	1×10	170/290
1955	Hiwassee[4]	U.S.A.	2×60	1×80	105
—	Limberg[5]	Austria	2×60	2×65	980/1430
—	Niagara[4, 5]	Canada	6×30	6×40	60/90
—	Upper Shira[5] (Sron Mor)	Scotland	1×5	1×5	100/160
—	Hagfors[5]	Sweden	2×20	2×20	580/665

[1] Date of installation of first pumping unit. [2] Reversible turbine/pump unit installed 1950. [3] Irrigation pumps. [4] Reversible turbine/pump unit(s). [5] Under construction.

* Mr. Cooper is Controller of the North West, Merseyside and North Wales Division of the Central Electricity Authority.

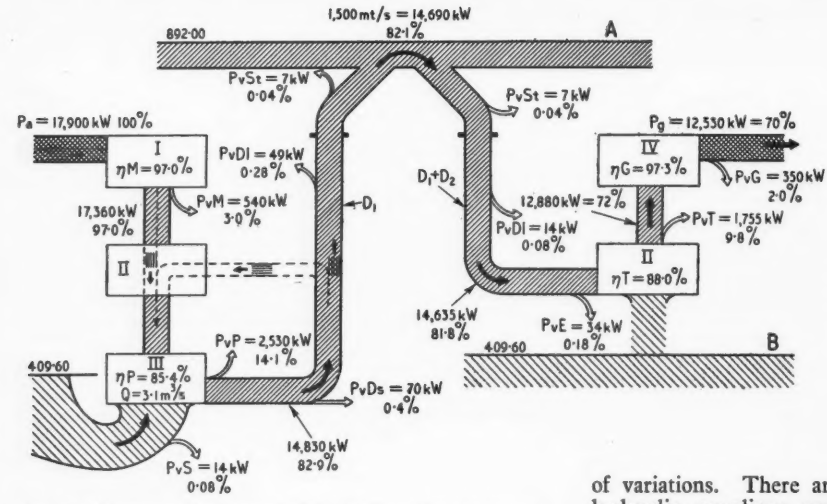


Fig. 2.—Diagrammatic representation of energy losses in pumped storage system

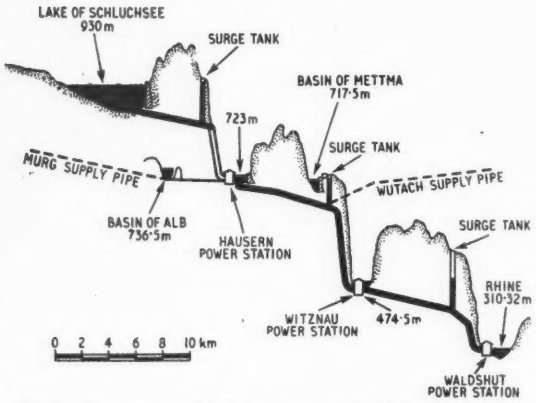
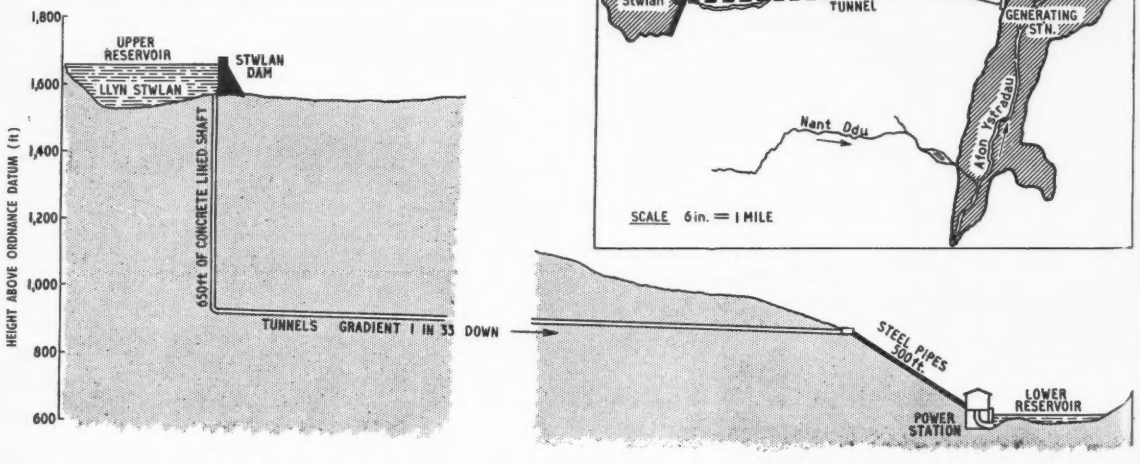


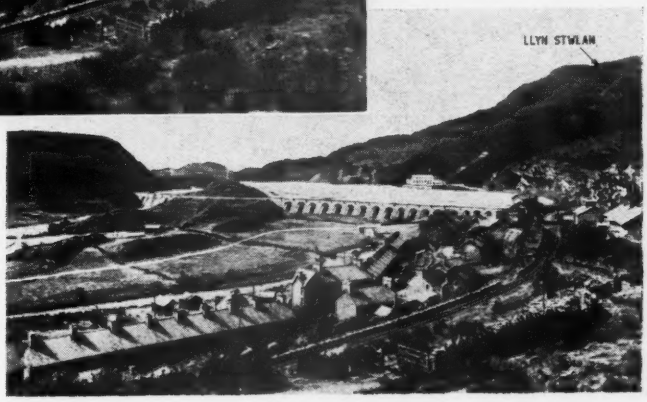
Fig. 3.—Cross-section of the Schluchseewerk (South Germany) pumped storage system

In some cases the water turbine is also designed to operate as a pump. This type of construction, which usually simplifies the layout and reduces the cost, has only been available for comparatively small heads of up to about 500 or 600ft, but it is now being arranged to operate at heads up to 1,000ft. The design of coupling connecting the water turbine and the pump is also subject to a number of variations. There are straight mechanical couplings, hydraulic couplings and wedge or friction couplings. Sometimes the whole plant unit is designed as horizontal spindle instead of vertical spindle, but with either type, precautions have to be taken to ensure that the pump and turbine impellers are under constant pressure in operation to avoid troubles due to cavitation.

One design of plant unit which differs from the normal is the plant assembly at the Lac Noir station of Electricité de France. In this scheme, the motor, turbine and pump are solidly connected to one vertical spindle. Both the turbine and the pump are situated below low water level in the bottom reservoir, and are therefore always under some hydraulic head. When the machine is running as a generator the turbine operates normally under the pressure head from the top reservoir and discharges into the bottom reservoir, and in order to avoid the losses which

Fig. 4.—The two reservoirs of the Ffestiniog scheme (North Wales) will be connected by a combination of tunnel and pipe lines





Figs. 5 & 6.—In the Ffestiniog scheme the Tan-y-Grisiau Valley (shown above) will be flooded to create the lower reservoir

would occur if the pump was thrashing round in a water-filled casing, compressed air is injected into the pump casing to expel the water; whilst generating, therefore, the pump impeller runs in air. Similarly, when the unit is pumping, compressed air is driven into the turbine casing to expel the water, the motor drives the pump direct and the turbine impeller revolves in air.

A detailed discussion of the advantages and disadvantages of these various types of construction is outside the scope of this article, but it can be stated that the overall efficiency of large pumped storage schemes is approximately of the same order. The design efficiency is usually round about the 70 per cent level, and the annual operating efficiency (electrical energy in : electrical energy out) is round about 65 per cent. Fig. 2, which is an energy flow sheet, indicates where the various losses occur.

The hydraulic aspects of a pumped storage scheme are, in general, similar to those of conventional hydro-electric schemes. Surge shafts, surge towers or relief valves are usually provided to minimise hydraulic shock on the system. The cross-section of the Schluchseewerk system in South Germany shown in Fig. 3 indicates how vertical surge shafts for three pumped storage schemes operating in series between Lake Schluchsee and the River Rhine have been accommodated in the mountainous contour of the locality. The Schluchseewerk scheme is well worth study by anyone interested in pumped storage, for, in addition to the interesting problems associated with the operation of three schemes in series, there is an opportunity of comparing the vertical plant units in the upper and middle stations at Hausern and Witznau with the horizontal plant units installed at the bottom station at Waldshut.

So far as the Ffestiniog scheme in North Wales is concerned, Parliamentary approval has now been given to plans which envisage an output capacity of 300 MW. The scheme will consist of a lower reservoir created by the construction of a dam at the village of Tan-y-Grisiau, near Blaenau Ffestiniog, and the construction of an upper reservoir at Llyn Stwlan which by means of a 90ft high dam will increase the storage capacity of an existing lake. Llyn Stwlan will have a storage capacity of 500 million gallons, with a surface area (full) of 31 acres, and the lower reservoir will have the same capacity with a surface area of 96 acres. The power station will be situated on the bank of the lower reservoir and the station and the upper reservoir will be connected by a combination of tunnel and pipe lines as shown in Fig. 4.

The creation of the lower reservoir will flood and render inoperable part of the old light railway which previously connected Portmadoc and Ffestiniog, and which ceased commercial operation in 1946. Fig. 5 shows the existing valley behind Tan-y-Grisiau, and Fig. 6 shows the same locality as it will look after the dam is erected, with the lower reservoir full. An impression of the power station can be seen on the right of the picture, and the situation of Llyn Stwlan is indicated on the hillside.

No decision has yet been made about the size of the plant units, the design of the pumps and turbines or whether the plant units will be vertical or horizontal. It has been agreed, however, that the external appearance of the buildings and dams will be made to harmonise as closely as possible with the surroundings. The front surface of the dams will be broken up by bush hammering, and the buildings will probably be faced with local stone. The station will be connected to the supergrid system of the Central Electricity Authority by a double-circuit 275 kV line from Ffestiniog to Connah's Quay. The consulting engineers for the pumped storage project are Messrs. Freeman, Fox & Partners, and associated consultants for the mechanical and electrical portions of the scheme are Messrs. Kennedy & Donkin. The scheme when completed is expected to be one of the largest single pumped storage projects in Europe, and it should be of considerable interest to technical visitors from all over the world.

Because of the economic situation the Central Electricity Authority have found it necessary, as part of their curtailment of capital expenditure, to suspend site work on the Ffestiniog project until March, 1957.

The residents of Blaenau Ffestiniog with their Member of Parliament, Mr. T. W. Jones, are wholeheartedly in favour of the project as it will provide extensive employment during a construction period extending over about ten years and the visitors, who will subsequently follow, will bring some much needed trade to the town. The amenity authorities such as the National Parks Commission and the various " preservation " and open-air organisations interested in this scheme are, if I may be permitted a little understatement, not exactly enthusiastic, but it has been possible to meet a great part of their requirements by replacing over-ground pipe lines by underground tunnels and by agreeing to adopt special exterior treatments for the buildings and dams. In addition to the executive architect who, together with the Authority's consulting architect, will be responsible for the architectural features of the design, a landscape consultant will be engaged to give advice concerning the general impact of the new proposals on the local landscape.

Engineering in Europe

ABSTRACTS FROM FOREIGN TECHNICAL JOURNALS

IT is now known that for different spark-machining operations two different circuits are used with advantage, one is the "Kipp" circuit and the other an oscillatory circuit. Also, some operations are better carried out with a vibrating, others with a continuously travelling electrode (feed movement). These different methods and several commercial types of spark-machining tools were comprehensively investigated in the Machine Tool and Production Engineering Department of the Technical University, Aachen.

The report presented includes voltage oscillograms showing clearly the different character of the operations according to the two methods mentioned, pictures and graphs representing the relations between spark frequencies and shapes of bores obtained, frequency relations of quantities of material cut out, power consumption and electrode consumption. Other diagrams relate boring speed with spark frequency and material eroded, material eroded with electrode consumption, surface finish with spark frequency.

A fairly important result, where the achievable finish and economy of the process are concerned, is the demonstration of the influences of re-ignition of sparks, or "spark-backs," on the operation, since these erode the electrode and not the work. However, this phenomenon can be eliminated by appropriate measures. Also, the scavenging dielectric liquid produces a number of important effects, since it improves not only the surface quality but also the structure and hardness of the surface layers. A number of important details of this new technological process are clarified by these investigations.—"Spark-Machining of Metals," H. Opitz, *Schweiz. Arch. angew. Wiss. Tech.*, Vol. 22, No. 2, pp. 41-47, February, 1956, in German.

Electro-Polishing

It may be said that the accepted term "electro-polishing" being actually a misnomer, might have delayed and impeded the correct interpretation of the process and of the phenomena on which it is based, since the superficial similarity with genuine, i.e. purely mechanical, polishing disappears at the first attempt of a closer study. Yet even the powerful tools of contemporary surface physics and chemistry, obviously combined with knowledge of electrolytic phenomena, do not lead easily to an explanation of the specific effects of the process. Particularly, Debye-Huckel's theory combined with measurements of anode resistance, polarisation and concentration of the electrolyte, only indicates that all these phenomena are not responsible for the "polishing" effects.

Much more fruitful is an application of Stern's double-layer hypothesis to the double layer actually constituted by the anions adsorbed at the electrode and by the diffusion layer facing it on the side of the electrolyte and possessed of positive excess charge density. Wigner and Bardeen's theory then enables the order of magnitude of the energies liberated at the anode to be determined; these energies are sufficient for extracting positive metal ions from the anode. The work function being a minimum for projecting points of the metal surface and a maximum for depressions in the surface, a possible, and even probable, explanation of the phenomenon seems to emerge within the frame of which the secondary effects of concentration polarisation, apparent resistance, etc., fall into their proper places. The paper contains a wealth of valuable and interesting experimental data not only supporting the author's thesis, but also useful from practical viewpoints.—"A Contribution to the Knowledge of the Mechanism of Electro-Polishing: New Method of Investigating the Processes at the Electrodes," C. Chalin, *R.G.E.*, Vol. 65, No. 2, pp. 87-117, February, 1956, in French.

Oil-Resin Mixtures

Synthetic or natural resins, admixed to insulating oils to increase their viscosity, may result in either an increase or reduction of the maximum loss factor in the low temperature range. The kind and amount of this variation depend on the type and characteristics of the constituents as well as on concentration of the resins in the oils. Between the position of the maximum loss factor of oils containing practically no paraffins and the viscosity characterised by its value at 50 deg C there is a significant relation. This was determined and graphed for the viscosity range 4 deg to 240 deg Engler. This curve and the empirical formulæ derived from it also apply to oils containing moisture, after being treated with fuller's earth, mixed with oils of different origin, or containing up to 23 per cent resins, provided their average dipole moment remains below 0·5 Debye.

In all the oils examined the dielectric loss phenomena taking place in the low temperature range could be explained by Debye's extended theory, so that it is likely that the latter actually applies to such insulating oils at low temperatures in commercial-frequency conditions. A point of discontinuity in the temperature-relation of the dielectric constant was discovered and found to be related to the point of solidification (thickening) of the insulating oils.—"The Dielectric Losses of Oil-Resin Mixtures at Low Temperatures," M. Beyer, *E.T.Z.(A)*, Vol. 77, pp. 161-166, 11th March, 1956, in German.

Explosion Chamber Pressures

Although explosion or expulsion chambers have partly been superseded in new designs of oil circuit-breakers, they are still used and even necessary in some modern types of breakers. In addition, an investigation of the pressure processes in this simplest type of chamber is very instructive and valuable for the corresponding, much more complicated, conditions in modern quenching chamber designs since the basic phenomena have the same character. The simplicity of the case of the explosion chamber is only relative, at least where exact theoretical treatment is concerned, since this is not possible even in this simplest case. However, the author carries out the calculation in a first and second approximation and is able to show that even the first approximation is in very satisfactory agreement with the results of measurements. The main purpose of the work is obviously to obtain criteria for the correct design of explosion or quenching chambers and these are actually obtained in terms of chamber geometry. Their application to a concrete chamber is given as a numerical example.—"Calculation of the Pressures in Explosion Chambers," J. Kracik, *Elektrotech. Obzor*, Vol. 45, No. 2, pp. 84-96, 1956, in Czech.

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review*.

Gas Turbine Developments

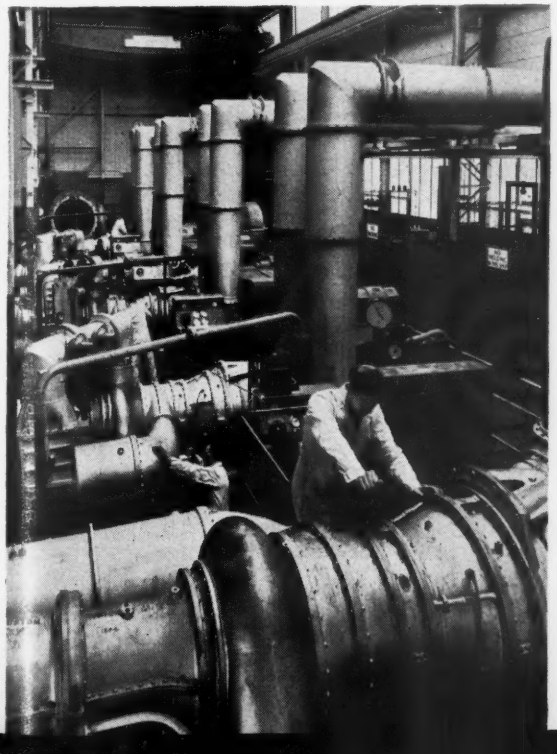
NEW TEST DEPARTMENT BUILT BY RUSTON AND HORNSBY

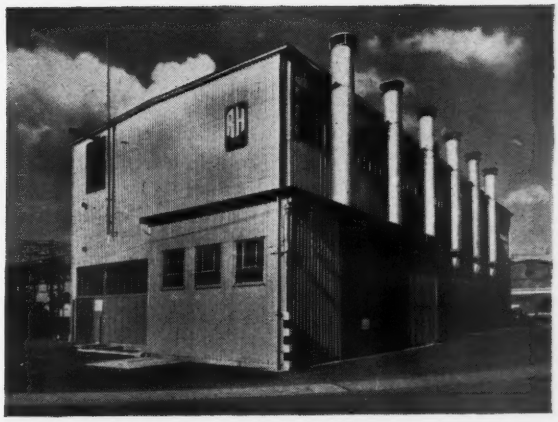
IT is almost six years since the Mark TA industrial gas turbine was built by Ruston & Hornsby, Ltd. Since then, this medium sized turbine has become accepted as a commercially successful prime mover and within two or three months there will be a Ruston gas turbine in every Continent, including several machines in North and South America. The prototype 750 kW machine is still in operation in the Lincoln works and is used extensively for test purposes.

The Mark TA machine is a simple open cycle gas turbine with a free output shaft and it is available in recuperative and non-recuperative forms; when running non-recuperatively it has an output of 1,300 b.h.p. With a weight one-third of that of the lightest alternative prime mover, its construction (self-contained "vertebrate" compressor and power turbine units) is such that no complex foundation work is involved and maintenance is simple. When installed for combined power and heat recovery purposes, it has reached an overall thermal efficiency exceeding 70 per cent.

One of the most important markets for a gas turbine in the 1,000 h.p. class is that where some use can be made of the exhaust heat rejected from the machine and so far half of the machines sold will be operated in conjunction with some form of waste heat recovery system. This is an attractive commercial proposition if the fuel is cheap, as is usually the case with gaseous fuels and coal tar fuel. The importance of the latter (at least in this country) was recognised at an early stage and much development work has taken place on fuel systems and combustion chambers for coal tar. Four machines burning coal tar fuel will be going into commission shortly in various parts of Essex and these form part of several which have been ordered for United Kingdom installations. Two machines have recently been installed in Italy and both are running on the natural gas exploited so extensively in north Italy since the end of the war; both incorporate waste heat recovery.

Five gas turbines undergoing trials in the new test building





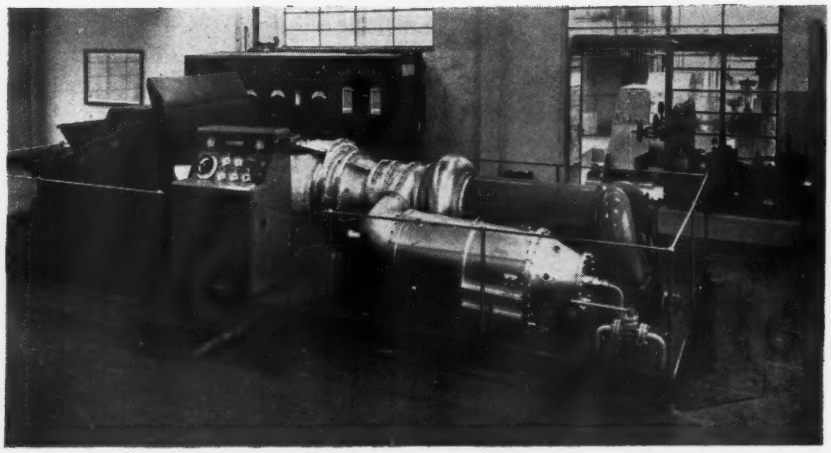
The Ruston & Hornsby gas turbine test building

An agreement has recently been signed between Ruston & Hornsby and Dresser Industries, Inc., which gives the latter's subsidiary company, Messrs. Clark Bros., of Olean, New York, the sole right of manufacture of the Ruston gas turbine in the United States. Two senior members of Clark Bros. engineering staff have made a preliminary study of production methods at Lincoln and a turbine which will burn either gas or gas oil will be despatched to the United States shortly for demonstration and subsequent sale.

Although much development work has been carried out on aircraft gas turbines in this country and the fruits have been generally available to the designer of industrial gas turbines, there are big differences between the two types of machine. The aircraft gas turbine normally uses various grades of lighter distillate fuels ranging from kerosene to gasoline. These fuels are amongst the more expensive and the demand has been to turn to lower grades of fuels. At Lincoln particular attention has been directed towards natural gas, sewage gas, blast furnace gas, producer gas, gas oil, residual fuel, creosote pitch (C.T.F.200), carburetted water gas, tar and pulverised peat. Most of these fuels present difficulty in their combustion, and with some the ash can be troublesome. A long term development programme is in hand on residual fuel and pulverised peat, and encouraging advances have been made; but the position has not yet been reached where either of these fuels can be considered to be suitable for commercial operation.

An elbow combustion chamber has been developed at Lincoln for use on gas oil, residual petroleum fuels and high calorific value gases. The air system of the combustion chamber is unique. The desired amount of combustion air is drawn off by a dividing plate in the air inlet and directed into the primary bowl, where flame stabilisation is achieved by means of the ring vortex formed. Fuel is sprayed into this bowl and combustion is initiated there by means of an igniter flame, after which it is self-sustaining. The bulk of the air delivered by the compressor is used to reduce the temperature of the combustion products to the level that the turbine can safely accept. This is done by directing the remaining air by two controlling vanes so that two vortices are formed in the main barrel of the chamber with opposite directions of rotation. In this way good mixing is obtained as well as cooling of the flame tube walls by cool air.

This combustion chamber is simple from the production and service points of view and has given very good service. One of its principal advantages is that the amount of com-



This installation in Italy has run for nearly 5,000 hours on methane gas and is designed for power generation and waste heat recovery

bustion air can be adjusted readily (during running if need be) to suit the requirements of different fuels. This has been particularly valuable in the combustion of various gases which can vary considerably in composition and are widely different from liquid petroleum fuels in their combustion requirements. Work is now in hand on dual fuel turbines which can burn two fuels (say, gas oil and natural gas) simultaneously in varying proportions.

Well over 1,000 hours' turbine testing has now been carried out on C.T.F.200 fuel. A refractory-lined combustion chamber has been developed because of two main combustion problems: first, the high radiation from tar fuels with the resultant problem of cooling metal-walled combustion chambers, and, secondly, the tendency to form "golden rain" in the exhaust which is associated with the high carbon/hydrogen ratio of tar fuels. The use of refractory walls enables the high flame radiation to be used to assist in the burning out of the "golden rain" (incandescent carbon particles). It presents, however, difficulties from the turbine point of view. Many refractory materials have been engine tested over extended periods and the present material has completed over 400 hours satisfactorily. With refractory linings, warming up and shut down of the turbine have to be taken more gradually but this presents no difficulty for the base load applications for which tar fuel burning turbines are normally considered.

An air blast assisted pressure-jet sprayer is used so that the best possible atomisation of the fuel can be obtained, leaving some margin in hand for any worsening of conditions that may occur in service. The air is drawn from the gas turbine compressor, through a pre-cooler to a single-cylinder piston compressor arranged to give a compression ratio of 2 : 1. A number of different tar fuels in the C.T.F.200 grade have now been tested and, as a result of this experience, it has been possible to decide on the type of fuel which the gas turbine can burn without difficulty. As a result, a restriction is placed chiefly upon the soda content of the tar, a condition which can be met without undue difficulty by the fuel suppliers.

With the development of combustion systems there has also been development of the associated control systems. For steady control, a flyweight type of governor is used with a servo system for fuel pressure regulation. This system can be arranged to control the pressures of different fuels, either singly or together. For the rapid acceptance of load, an air/fuel ratio limiter is used which over-rides the governor and maintains turbine temperatures at permissible values. In this way the turbine is worked as hard as the dictates of safety will permit and the most rapid response possible is achieved. For load rejection without overspeeding, the governor quickly cuts back the fuel to the minimum practical value and blow-off valves are used to dump air from the compressor exit, producing a very rapid run down of the compressor and its driving turbine.

Manual starting is normally provided by means of a hand-wheel rotated in one direction during a start and which actuates a hydraulic selection section and an electric switching section. The electric switching section controls such items as the auxiliary motor for fuel and lubricating oil, the igniter, and the starter motor. The hydraulic selection section controls the supply of fuel and regulates the supply pressure during the starting sequence. Various interlocks are provided in the starting control to give the maximum protection against mechanical defects or operator error while maintaining simplicity from the operator's point of view.

Further developments have resulted in a push-button starting equipment in which the manual starting wheel is motorised and driven at a controlled rate. With this equipment the turbine can be started from cold and brought to full load in less than 100 seconds. It is possible for the turbine to be started up and put on load by an electrical impulse such as might be obtained by dialling a number on a telephone many miles away.

So confident were the Ruston designers and sales staff in the potential commercial value of the TA turbine that provision was made from the earliest stages for batch production. All machinery and plant lay-out at the Anchor Street works was accordingly planned for series production on a scale which is said to be currently possible in no other works outside America.

The growing demand fully justified this policy. The shops and production facilities have been reorganised in recent years and the culmination of this phase of development is in the erection of a new turbine test building and propane/air plant. This new building is one of the few gas turbine test shops in the world in which six turbines can be tested at once on various types of fuel.

The propane/air plant will supply a mixture which can be delivered to the turbine test room with a heating value adjustable between 600 and 1,200 B.Th.U/cu ft and employs Shell propane, brought to the works by road tankers equipped with transfer pumps.

Summer School on Communications

A SUMMER school on communication theory, modulation and noise is to be held from 1st to 13th July at the Department of Electrical Engineering, The University, Edgbaston, Birmingham, 15. The school is intended for engineers in the electrical communications and allied fields who have taken their degrees without much theoretical work in communications, or who feel the need for a refresher course.

The subjects and lecturers are as follows:—Amplitude modulation—modulation circuit theory, Prof. D. G. Tucker (Birmingham University); frequency modulation theory, Dr. K. R. Sturley (B.B.C.); f.m. broadcasting, Dr. Sturley; impulse interference in f.m. broadcasting, Dr. R. D. A. Maurice (B.B.C.); pulse modulation, Dr. J. E. Flood (Siemens Bros.); communication theory, Dr. D. A. Bell (Birmingham University); origins of noise, Dr. Bell; and detection of signals in noise, Mr. J. W. R. Griffiths.

The fee for the course will be £8 and residential accommodation can be provided at extra cost. Full particulars and application forms can be obtained from the Director of Extra-Mural Studies, The University, Edmund Street, Birmingham, 3.

VIEWS on the NEWS

By REFLECTOR

LAST week's I.E.E. lecture on the Sir Adam Beck No. 2 station of the Hydro-Electric Power Commission by the chairman of the Commission, Dr. R. L. Hearn, gives me an opportunity of mentioning a historic link with Niagara power. This is the wall plaque in Brown's Hotel,

London, W.1, seen in the accompanying picture. The inscription reads as follows:—

> "The Niagara Room. The International Niagara Commission composed of Lord Kelvin, chairman, England, Professor E. Mascart, France, Dr. Coleman Sellers, United States of America, Lt.-Col. Theo. Turrottine, Switzerland, Prof. W. Cawthorne Unwin, secretary, England, was organized in this room, June 21, 1890, by the Cataract Construction Company, Edward Dean Adams, president, 1890-1910. This Commission publicly announced its opinion in favour of the adoption of electrical methods as the chief means of distributing Niagara power. The inauguration of the alternating current power system at Niagara was followed by its adoption throughout the world."

* * *

Southern Electricity, the magazine of the Southern Electricity Board, reports that

> "there is no truth whatever in the rumour to the effect that the Board are now turning down contracting work owing to the amount of work in hand. In some places, however, consumers are being warned that there may be some delay in carrying out work."

Unless the local electrical contractors are also overwhelmed with work they should step in and see that there is no delay.

* * *

Mr. Woodrow Wyatt was bold enough, in a television programme last week, to point out to members of the Amalgamated Engineering Union that if they did not vote in forthcoming elections for Executive Council members there was a danger of the union being dominated by Communists. His broadcast included several "shots" of interviews with union members who gave various (generally trivial) reasons why they did not usually attend their branch meetings or vote in union elections. Contrasted with this attitude was that of a recently deceased member of the Electrical Trades Union to whom the following tribute is paid in the May issue of *Electron*, the union's journal:—

> "Although throughout his 28 years of membership of the E.T.U. he did not hold any official positions he could always be relied upon to attend meetings, put forward his point of view, and help the branch in every way he could."

The trade union movement could do with many more of his kind.

* * *

There seems to be undue optimism in a note appearing in the *Grimsby Evening Telegraph*. It starts rather fatuously by saying that housewives will be able to call themselves "atomic" housewives after October when the Calder Hall plant gets going. From then onwards, it goes on, there will be more electricity.

> "Already in the industry they are talking about a rating system. They expect that in time we shall be charged for electricity in the same way as for water."

This idea is a very old one; it was put forward as a future possibility by Dr. S. Z. de Ferranti many years ago. Whether the advent of "atomic" electricity will eventually enable it to be done it is rather soon to say and I do not think that "they" are talking about it as an almost immediate possibility. Electricity "on tap" would certainly eliminate tariff-structure troubles and simplify accounting—but there's always that bugbear distribution costs.

* * *

In Power Convention week it may be of interest to cull from the *Electrical Review* of the period what happened at the Municipal Electrical Association's first Convention sixty years ago—in June, 1896. It was held in London under the presidency of Arthur Wright (of Brighton) who dealt in his address with the objects of the Association and later read a paper on "The Cost of Electricity Supply." The other papers presented were "Electricity Supply at 220 Volts" by A. S. Barnard (Hull); "Alternating Current Stations and High Voltage Lamps" by H. W. Couzens (Taunton); "The Control by Municipal Authorities of Consuming Devices and the Wiring Connecting Them to the Mains" by C. H. Wordingham (Manchester); "Electricity Works Records" by A. B. Mountain (Huddersfield); "Cable Specifications and Tests" by J. A. Jeckell (South Shields); "The Organisation of an Electricity Works Staff" by E. T. Ruthven-Murray (Worcester); and "Electric Lighting and Traction" by J. Hesketh. On the last day the Convention moved down to Brighton where the president was borough electrical engineer. After a civic welcome, a paper on "Extensions to Outlying Districts" was read by A. H. Gibbings (Bradford) and later the delegates inspected the electricity works in North Road.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The Brush Group, Ltd., announce that the following appointments were made at a meeting of the board recently:—**Mr. G. Eley** to be chairman. This appointment is made following the retirement of **Sir Ronald Matthews** from the chairmanship, as foreshadowed in his statement circulated with the accounts for 1955. **Mr. Miles Beevor** to be deputy chairman and joint managing director, and **Mr. I. T. Morrow** to be joint managing director.

Mr. Beevor joined the Group as deputy managing director early in 1951 and was appointed managing director the following year.

Mr. Morrow joined the Group as a director in December, 1951, and was appointed deputy managing director in October, 1952. He is president designate of the Institute of Cost and Works Accountants.

The Jackson Electric Stove Co., Ltd., announces the appointment of **Mr. A. S. Oldhams,** A.M.I.E.E., M.S.M.A., as director and general manager of the company following the retirement of **Mr. S. C. Hurry** reported in our last issue. Mr. Oldhams joined the Jackson Electric Stove Co. in 1949 as chief sales executive and was promoted to sales manager in 1952. Before joining Jackson's he was for many years with the Revo Electric Co., Ltd., latterly as engineer and manager of that company's London branch. During the 1939-45 war he served as an electrical lieutenant in the Royal Naval Volunteer Reserve.

Mr. A. S. Oldhams

At the recent annual general meeting of the British National Committee, World Power Conference, **Sir Vincent de Ferranti,** M.C., chairman and managing director of Ferranti, Ltd., was re-elected chairman of the Committee for a further term.

Siemens Brothers & Co., Ltd., announce the appointment of **Mr. H. S. Peet** as sales manager of the Distribution Equipment Division and **Mr. H. C. C. Budd** as sales manager of the Power Cables and Lines Division.

Mr. Peet joined Siemens Brothers in 1912 as a qualified radio operator and served for two years at sea on Blue Funnel Line ships. Transferring to the Cable Department in early 1914 and returning to that department after service in the 1914-18 war, Mr. Peet made several voyages on the company's cable ship *Faraday*, laying submarine cables to Central and South America. He was appointed manager of the Switch and Fusegear Department in 1925 and subsequently became

Mr. H. S. Peet

Mr. H. C. C. Budd

responsible for house service meters and accessories.

Mr. Budd joined the Apparatus Department of Siemens Brothers in 1908. Transferring to the Cable Department eighteen months later, he served in the testing section and the cable estimating and design section. Demobilised in 1919, he returned to the Outside Contracts Department and in 1922 took part in a submarine cable operation on the *Faraday* to the West Indies. Mr. Budd served in both the manufacturing and sales sides of cables, and was appointed assistant sales manager in 1945 and deputy sales manager in 1948, becoming manager of the Power Cables Department in 1954.

In order to fulfil his expressed wish of enjoying his later years free from business worries, **Mr. M. Burningham** is, on the occasion of the 60th anniversary of his joining Keith Blackman, Ltd., on 16th June next, retiring from his offices as chairman and director. He has served as a director for the past twenty-seven years.

Mr. D. S. Woodley, M.I.Mech.E., M.I.H.V.E., F.R.S.A., the present managing director and deputy chairman, who has served the company for the past forty years, has been elected to succeed Mr. Burningham as chairman.

Mr. H. V. Harris will resign as chairman and managing director and from the board of Bennis Combustion, Ltd., on 30th May owing to ill-health. He will also resign as chairman and managing director of the company's subsidiaries, Bennis Mechanizations and Saxon Engineering Co.

Mr. J. S. Rivaz, A.R.Ae.S., has been appointed technical sales manager to Smiths Aircraft Instruments, Ltd., as from 1st June in succession to **Mr. A. I. O. Davies** who is leaving the company to emigrate to Canada. Mr. Rivaz is at present technical services manager to Kelvin & Hughes (Aviation), Ltd., one of the Smiths Group of aviation companies.

Mr. D. G. Johnson, who was deputy technical sales manager and personal assistant to Mr. L. Morgan, director and general manager of Smiths Aircraft Instruments, Ltd., has been appointed contracts manager to S.A.I.

Mr. J. M. Ridley, of Grundig (Great Britain), Ltd., is leaving his present position of advertising and publicity manager to become personal assistant to Mr. A. E. Johnson, chairman and managing director. He will be succeeded as advertising manager on 1st June by **Mr. R. F. Long,** who for the past four years has been advertising manager of Enfield Cables, Ltd.

Mr. A. C. Smith, manager of the London office of G. & J. Weir, Ltd., has been appointed to the executive board. Mr. Smith commenced his apprenticeship with Weir's in 1930 and has had considerable experience at home and abroad in the installation and operation of Weir equipment. He was appointed manager of the London office in 1948, and will now return to the head office in Glasgow as sales director.

Mr. J. R. Rylands, M.Sc., M.I.Mech.E., M.I.E.E., F.Inst.F., who succeeds **Mr. R. H. Gummer** as president of the Institute of Fuel in October next, was educated at the Central High School and the Central Technical College, Leeds, and served an apprenticeship with Henry Berry & Co., Ltd., which was interrupted towards its close by service overseas in the Middlesex Regiment in the 1914-18 war. On demobilisation he returned to the University of Leeds, where he graduated B.Sc. with first class honours in 1921, subsequently proceeding to M.Sc. in 1926.

Mr. J. R. Rylands

His first position after graduating was as assistant electrical engineer to the Taquah & Abosso Gold Mining Co., on the Gold Coast, where he ultimately became chief engineer of the Abosso Mine. He returned to England in 1924 to take up the position of assistant engineer to E. Green

& Son, Ltd., fuel-economiser makers, Wakefield. He has devoted the past thirty-two years to the cause of fuel efficiency, and is now chief engineer and a director of the company. Outstanding was the pioneer work done with J. R. Jenkinson during the latter part of the last war on fouling problems associated with economisers and air heaters. The first results were presented to the Institution of Electrical Engineers in 1943, and the paper was awarded the John Hopkinson Premium.

Mr. Rylands has also been active in the electrical branch of the engineering profession, having served as chairman of the North Midland Centre of the Institution of Electrical Engineers, and on several committees of its Council. He is a Justice of the Peace and has given much of his time to the hospital service in Wakefield, being a governor of a local hospital before the National Health Service came into being, and a member of a Hospital Management Committee thereafter.

Mr. R. A. Butcher has been elected to the board of Wilec, Ltd., electrical wholesalers. He joined the company in March, 1955, as assistant to the managing director and was subsequently appointed sales manager. Previous to this he was with the Sun Electrical Co., Ltd., from 1947 as sales engineer. Mr. Butcher commenced his career with Johnson & Phillips, Ltd., as an engineering apprentice and completed his apprenticeship in their switchgear sales and estimating section.

Mr. R. A. Butcher

The British Transport Commission has appointed **Mr. E. Claxton,** B.Sc.(Eng.), A.M.I.C.E., A.I.Mech.E., A.M.I.E.E., electrification engineer, electrical engineering new works and development section, to be assistant electrical engineer (development), and **Mr. W. J. Webb,** B.Sc.(Eng.), A.M.I.E.E., assistant for substations, electrical engineering new works and development section, to be assistant to the electrical engineer (systems).

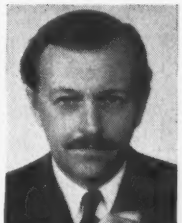
Mr. Claxton was educated at Merchant Taylors' and University College, London. Between 1931 and 1937 he was employed by Kennedy & Donkin on construction of the national grid and other electrical works in Scotland and Northern Ireland. He joined the L.N.E.R. in 1937 and was engaged on traction substation and cable work. From 1942 to 1946 he was loaned to the Admiralty. Returning to the Chief Electrical Engineer's Department, L.N.E.R., in 1946, he was associated with the design and production of electric locomotives and multiple-unit stock for the Manchester-Sheffield electrification. He was appointed assistant electrification engineer, and subsequently electrification engineer, Electrical Engineering New Works and Development Section, Railway Executive, in 1951, being concerned with the recent report on the choice of system for electric traction.

Mr. Webb completed his education at University College, London University, where he was awarded Professor (Sir) J. A. Fleming's prize in electrical engineering. In 1923 he entered the service of the Southern Railway in the Department of the Electrical Engineer for New Works and after gaining experience in the various sections was placed in charge of the drawing office in 1930. In 1947 he was appointed assistant for power supply (new works) in the Chief Electrical Engineer's Department, in 1950 senior technical assistant in the electric traction section of the Mechanical and Electrical Engineer's Department, Southern Region, and in 1952 assistant for substations in the Electrical Engineering New Works and Development Organisation.

Mr. G. W. Wilson, M.B.E., a director of the Belmos Co., Ltd., has joined Mr. R. T. Lythall in London to further the expanding interests of the company in the south. Mr. Wilson has been with the company since 1920, and until recently was director in charge of the Glasgow office covering the whole of Scotland.

The **Manchester-Liverpool Electrical Trades Inter-City Golf Meeting** was held at the Mere Country Club on 16th May. Twelve matches were played and the net result was a draw, six being won by Manchester and six by Liverpool. As Manchester were last year's winners of the J. H. Farthing Cup they retained the trophy. "Ken Mackley" tankards were presented to the two competitors on each side who won their matches by the biggest margins.

Mr. A. G. Asquith-Leeson, of Harbottle-Leeson, Ltd., electrical wholesalers, is to be installed as Lord Mayor of Portsmouth on Monday next. He is a member of the Electrical Wholesalers' Federation.



Mr. Asquith-Leeson

Mr. W. Rewcastle, B.Sc., M.I.E.E., A.M.I.C.E., has been appointed deputy sub-area engineer in the No. 3 (Sheffield) Sub-Area of the Yorkshire Electricity Board. Mr. Rewcastle was educated at the Technical College, Sunderland, and served an apprenticeship with A. Reyrolle & Co., Ltd., with whom he became junior assistant in the Contracts Department in 1934. In 1937 he joined the London Power Co., Ltd., as junior control engineer, and a year later went to Sheffield as an assistant engineer in the Electricity Department. From 1946 to 1948 he was mechanical and electrical engineer, H.M. Colonial Service, Gold Coast, and since 1948 has been with the Yorkshire Electricity Board as a senior assistant construction engineer on the staff of the No. 3 (Sheffield) Sub-Area, and (from 1950) as senior assistant engineer distribution design. He is chairman of the Sheffield Sub-Centre of the Institution of Electrical Engineers and from 1948 to 1953 was hon. assistant secretary of the Sub-Centre.

Mr. D. Allsop has been appointed manager, Construction Department, British Thomson-Houston Co., Ltd. **Mr. A. S. Kettle,** M.I.E.E., who has been manager since 1948, has relinquished the position in order to devote his full time to other duties with the company.

Mr. D. Allsop

Mr. Allsop commenced his career as a power station apprentice in 1917. He joined the B.T.H. Construction Department in 1923 and from 1929 to 1940 he was on the B.T.H. district construction staff, first at Manchester and then at Stirling. In 1940 he was appointed to head office, Rugby, and from 1948 held the position of superintendent of construction (electrical) until his appointment as assistant manager of the Construction Department in 1953.

It was stated in the caption to the lower picture on page 847 of our last issue that Mr. Guy Campbell was in the centre: actually it was **Mr. H. G. Campbell.**

OBITUARY

Mr. David Lawson, A.M.I.C.E., county lighting engineer of Lanarkshire, died on 13th May at the age of forty-six. He began his career on the staff of the middle ward of the County of Lanark District Engineer's Department in 1927. In 1943 he was appointed first county lighting engineer. Mr. Lawson was a former chairman and founder member of the Scottish section of the Association of Public Lighting Engineers.

Mr. W. R. W. Kelley, Associate I.E.E., died on 10th May at the age of fifty-six. Before vesting day Mr. Kelley was the electrical engineer and manager of the Prestatyn electricity undertaking, North Wales, for over twenty-one years. Subsequently he was district commercial officer in the Chester District of the Merseyside and North Wales Electricity Board, and more recently, until his death, was a senior member of the No. 3 Sub-Area commercial staff.

Niagara Power

I.E.E. Lecture by Chairman of Ontario Hydro-Electric Commission

Dr. R. L. Hearn, chairman, Hydro-Electric Power Commission of Ontario

AT a meeting of the Supply Section of the Institution of Electrical Engineers on 16th May Dr. R. L. Hearn, B.Sc., chairman of the Hydro-Electric Power Commission of Ontario, gave a lecture entitled "The Sir Adam Beck Generating Station No. 2 at Niagara—A Major Canadian Hydro-Electric Development."

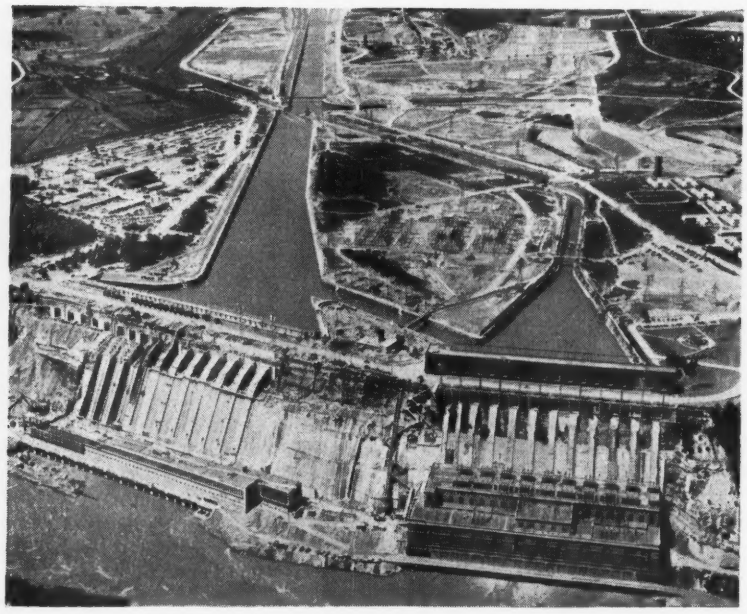
He said that the Commission had had to face more than engineering problems, for there had been an international problem in the question of diversion of water. Water could not be taken out of the Niagara River without an international treaty. When the building of the first plants started, if all the applications for licences to develop power had been granted there would have been consumed more water than was available in the river. To overcome that difficulty a treaty had been made between Canada and the U.S.A.

When developing the Sir Adam Beck Station No. 1, they had used up all the available water under the international treaty, and in order to get sufficient water to run it, the Commission had purchased the Toronto Power Co. and the Ontario Power Co. Between Lake Erie and Lake Ontario there was a difference in elevation of roughly 327ft. The initial plants at Niagara Falls had only developed slightly over 100ft of the total of 327ft at the Falls itself. The Sir Adam Beck No. 1 and the Sir Adam Beck No. 2 stations had been laid out to use as much of the 327ft as was economic. In all they had used 300ft of the total. This was the scheme that was being used now at the Sir Adam Beck No. 2 and would be used also on the American side when they had decided who was to get the water to develop their side.

One of the problems had been the question of the preservation of the scenic beauty of Niagara Falls. As a result of conditions that had developed in the 1939-45 war, when the demand for power for munition plants had been so urgent, the Canadian and United States Governments had, by an exchange of letters, permitted additional diversion of water so as to run heavy plant at Niagara Falls to the limit of its capacity. With that experience, it had been possible to prove to the opponents of further diversion that the scenic beauty could still be preserved with a lesser amount of water. After a new treaty had been agreed upon between the United States and Canada in 1950, the method of allocation had been changed. In the new treaty economic beauty was given a definite amount of water. In a year, in daylight hours, 100,000 sec ft of water must be allowed to flow over the Falls, and in the night hours 50,000. In the winter months, the figure was 50,000 over the 24 hours.

Another problem had been that of taking a large quantity of water out of the Niagara River without disturbing too much of the flow pattern and without entraining ice in the intake during the winter period. This was a problem which had been solved at Niagara for the first time. The idea had been conceived when designing the Sir Adam Beck No. 1 of putting a submerged tube in the river with a slot in it. The trick was to pull water into that slot in the length of the pipe at a uniform rate per running foot. They had tried using just the difference in pressure between the inside and the outside which caused a frictional loss to develop inside the tube. This had been found to be too sensitive. So the idea of an "induced loss" had been conceived. In the intake itself fins were put in the slot and these fins were set at a certain angle so that the vertical component to the intake created an induced loss that could be definitely figured and maintained and would be somewhat greater than the friction itself. In that way it had been possible to get a stability of operation over a wide range of flows.

The Sir Adam Beck hydro-electric station, Niagara



At the Sir Adam Beck No. 1 it had not been found necessary to use this in the plant, but when faced with the development of the Sir Adam Beck No. 2 and the problem of taking a large quantity, they had gone back to that intake which had been developed 25 years ago. Tests had indicated that between half-load and full-load there was no greater variation in the distribution along the length than 10 per cent.

Dr. Hearn then showed slides of the construction of the Sir Adam Beck No. 2 Station and commented on them. He also showed a coloured film of the construction, which he later presented to the Institution.

A vote of thanks to Dr. Hearn, moved by Dr. L. G. Brazier and seconded by Dr. J. R. Mortlock, was accorded with acclamation.

INDUSTRY AND THE HOUSE

The Coal Debate : Problems of Automation

By A. M. F. PALMER, A.M.I.E.E., M.P.

THE writer has been in Germany looking at Technical Colleges and was therefore not present in the House so as to give an accurate first hand account of the exciting events of that Thursday when twenty-five Conservative Members led by the intrepid Mr. Nabarro divided against the Government over coal. True they were safe in the knowledge that the Opposition would not vote but their action has created a stir the ripples from which have not yet died down.

Mr. Nabarro apparently said that while he and his friends welcomed any measure which would increase the economic production of coal, they declined to give assent to loans without first being assured that these had proper scrutiny. In a reference to the earlier statement made by the Prime Minister on the future of the Select Committee on Nationalised Industries Mr. Nabarro complained that all the Prime Minister was proposing was " accountability in retrospect." What he and his friends wanted was that instead of the Minister agreeing with the Chancellor of the Exchequer " within the fastness of the Treasury " to the sum of money to be allocated to the National Coal Board for the ensuing year they should instead put the proposal before the House of Commons. Control should be taken from " the cabal in the Treasury " and transferred to the place where it properly belonged.

After several supporting speeches from fellow rebels, Mr. Nabarro's amendment was put to the House. It was rejected by 143 votes to 23 amid what I am told were loud Opposition cries of " Resign." I cannot believe Mr. Jones has heard the last of the business. In a few short months he has already placed himself in the position where once stood his predecessor Mr. Geoffrey Lloyd for he is often in greater danger from those who form his rear than from the army facing him. His Conservative critics seem to find more ground for humour in his remarks than support for his undoubted realism in argument.

Nationalised Industries' Accounts

Terms of reference published for the new Select Committee on Nationalised Industries are much broader than those given to the earlier Committee, which was obliged, it will be remembered, to report to the House " No progress." The new Committee is to examine all the reports and accounts of the Boards and there are no exempting provisions at all. The political position in the House over the Select Committee is novel for while the Government itself might be described as almost neutral in attitude it bears great pressure from those on its back benches. Among the Opposition quite a knot of the nationalisation theorists (if that is the right word) want a committee of some kind, but trade union opinion finding its focus on the Front Bench is scornful of the idea in the main. For myself I am glad the Government is prepared to experiment once more.

Controversy over automation in industry is now developing in Parliamentary circles. For quite a time the official view was that automation was nothing more than an acceleration of the continuing processes of mechanisation. However, the recent trouble in the motor-car industry and developments overseas, in the United States particularly, have brought about a noticeable modification of the former austere approach. In addition, firmer facts and figures are now available to Parliament because of the publication this week of the report by the Department of Scientific and Industrial Research. This points out that Britain, dependent as she is on foreign trade for her commercial existence, must take the lead in developing automation and the real issue is how quickly it can be brought into use. The report states that while capital flow may be difficult the most powerful brake on the rate of introduction is likely to be the lack of technologists and skilled engineers.

On the point that most concerns Labour and trade union spokesmen in the House of Commons, which is the effect of automation on employment, the report is soothing. It argues that the rate of introduction in the nature of things is bound to be gradual; hence changes in employment patterns can be taken evenly. The D.S.I.R. investigation draws attention to the great importance of training and argues that a vast amount was discovered during the war years when quite new skills were developed in people late in life, both in the military and industrial fields. As soon as the House resumes we are likely to have a full scale debate on the social consequences of automatic methods. This might well be linked with advantage with the promised discussion on the Technological Education White Paper.

Restrictive Trade Practices

The Restrictive Trade Practices Bill has now finished its weary progress through the Committee stage. Many Members, who had followed the measure in the early days, have now faded away and left the field to the lawyers and to heroes such as Mr. George Darling, Mr. Fletcher and Mr. Jay, who really seem to understand the intricate clauses and sub-clauses of the Bill.

A nearly final speech was made by Mr. Darling, when he moved an amendment to leave out that sub-section of Clause 22 which provides that the maximum number of members of the Monopolies and Restrictive Practices Commission, should be reduced from twenty-five to ten. Mr. Darling said that he felt the Commission in its present form ought to be left alone, so that it would be big and competent enough to deal with the many restrictive practices which might win the approval of the Court. The sub-section was reactionary and out of keeping with the Minister's professed desire to end the criticised practices.

Resisting the amendment, Mr. Derek Walker Smith thought the size of the Commission must depend upon the scope of its functions. It was desirable to avoid any clash between the Court and the Commission and suit the size of both Court and Commission to the volume of work to be done. Like so many other well-argued proposed changes this particular amendment was rejected. When the House resumes after Whitsun we shall I hope proceed to Report and Third Reading and then dispatch this dreary Bill to the Lords.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Are Standards Lower?

THE letters from Mr. Sowman and Mr. Barfield in your issue of 11th May have given a very effective answer to Mr. Turner's complaint regarding the quality of electrical products.

As part of our jubilee celebrations this year we are endeavouring to find for our museum the oldest pieces of certain classes of Ellison switchgear and have already found many still in service that were installed over 40 years ago.

Visitors to our stand at the recent Electrical Engineers' Exhibition may recall that we had on show a star-delta starter that was still giving satisfaction when taken out of service 42 years after installation. This is far from being an exceptional case. As recently as last week we were informed of a rotor starter that we supplied in 1912 still giving excellent service controlling a 32 h.p. squirrel cage induction motor in a Manchester factory.

Birmingham, 22B. S. HALLAM BAILEY,
Publicity Manager,
George Ellison, Ltd.

B.B.C. and Industry

IN "Views on the News" in your issue of 11th May, "Reflector" complains that the B.B.C. services never mention the names of industrial concerns that accomplish notable feats of production, especially in the export field. This is not so; I am sending for your information the text of thirteen items from recent B.B.C. news bulletins, all of which mention the names of British firms that have secured major contracts either in this country or abroad.

The B.B.C. must, of course, refrain from giving preferential treatment to the products of any particular firm, but when an achievement is of sufficient importance and interest as news the name of the firm is mentioned in our news bulletins; this applies to both the Sound and Television Services.

London, W.1. HAROLD BISHOP,
Director of Engineering,
British Broadcasting Corporation.

["Reflector" has seen Sir Harold Bishop's letter and says that he is sorry if his strictures were too sweeping; he was somewhat irritated by the ratio of publicity given to records, films, etc., to that accorded industrial achievements. He appreciates the mentions quoted by Sir Harold (which include a number of electrical items) and hopes that the B.B.C. will continue to do what it can to stimulate interest in electrical export business.—*Editors.*]

Capital for Nationalised Industries

THE article under this title by Mr. D. J. Bolton in your issue of 4th May dealt with some important aspects in a way which was hardly likely to give anyone less well versed than the author a sufficiently complete picture of the capital requirements of electricity supply.

Mr. Bolton's principal object was to compare the "intensity of capitalisation" of electricity with gas supply and with the Unilever combine (which I should prefer to describe as heavy chemicals rather than "light industry"). The figures given may be accurate enough as comparative values, namely, that electricity supply needs, for the same turnover, more than twice as much capital as gas supply and nearly 12 times as much as Unilever. Where the article is misleading, however, is in giving the figures deduced for comparative purposes as though they were absolute values. To say, for example, that the capital requirements of the electricity supply industry are £311 for every £100 turnover is very much an understatement.

Those who were concerned with the management of individual supply undertakings know that the capitalisation was usually at least twice as much, i.e. it took at least six years to turn over one year's revenue. If one takes the annual reports of the Central Authority and plots the value of fixed assets for the last five years, the average rate of increase is found to be about £155 million a year. If the revenue over the same period is also plotted the average increase comes to £30 million a year; by simple proportion, therefore, the amount of fresh capital that has been required to give an additional £100 turnover is £516 and probably the total amount required, including working capital, is considerably in excess of this figure. It is evident, therefore, that the capital requirements of the industry are inherently very large and that no substantial proportion can be provided out of revenue without a very considerable increase in tariffs.

London, W.C. "STATIST."

Restrictive Trade Practices

DURING the resumed committee stage discussion on the Restrictive Trade Practices Bill, Liberal and Labour M.P.s sought to amend Part III, which deals with the reconstitution of the Monopolies Commission, so that the Commission should not be reduced in size.

Mr. George Darling said he appreciated that references to the Commission concerning common practices would now fall by the way, but other important matters such as tenders for electrical generating machinery, were still left to the discretion o fthe President of the Board of Trade to decide whther they should continue or not. He would like more information about the electrical manufacturers' arrangements to be made public so that the House could see the matter in its proper perspective and against the background of the country's export trade.

He said the Bill itself might cause the formation of what were called "interconnected bodies-corporate" for the purposes of getting around its provisions.

Mr. Derek Walker-Smith, Parliamentary Secretary, Board of Trade, replying, said that in Part III the Government sought to apportion the work between the Restrictive Practices Court and the Commission on a logical basis, seeking to give the Court jurisdiction where the issue was clearly justiciable, over restrictive agreements affecting the home market. Agreements exclusively affecting the export market and "monopolies of scale" would be referred to the Monopolies Commission.

The amendments were negatived.

On an another amendment concerning references to the Commission, Mr. Walker-Smith said the Government intended to leave to the Commission only those existing references which could be reported upon before the Bill came into force, plus those on a purely factual basis.

Mr. R. Edwards, commenting on this, said one of the references to be excluded concerned electric batteries yet this had no relationship to the new Court. Another reference being excluded related to street lighting equipment.

The committee stage was completed.

INDUSTRIAL NEWS

Contract Price Adjustment Formulæ

The British Electrical and Allied Manufacturers' Association has issued the figures for its contract price adjustment formulæ. In each case the rate of pay for adult male labour at 12th May is deemed to be 175s. The "cost of materials" figures are:—For electrical machinery and equipment, the Board of Trade index figure published on 12th May is 195·1. For turbo-generating and allied plant: Materials used in mechanical engineering industries, 175·9; blast furnaces and iron and steel melting and rolling (40 and 41), 157·0. The price of ¾in o/d 18 s.w.g. brass condenser tubes (*Metal Bulletin*, 11th May) is 4s 7⅛d per lb.

Piccadilly Circus Signs

An inquiry was held in London on 15th May into an appeal by Claude-General Neon Lights, Ltd., for permission to erect two illuminated advertisement signs on the Criterion building in Piccadilly Circus. The appeal was contested by Westminster City Council. For the appellants it was contended that the proposed signs could have no effect on any architectural interest which might remain in the building. Negotiations were begun last year for the demolition of the existing building and the construction of a new one on the same site. For the City Council it was stated that the building was the only one of historical interest in the Circus and that the signs would mar the architectural features. Mr. S. J. Docking, a senior inspector appointed by the Ministry of Housing and Local Government to conduct the inquiry, said that he would inspect the Circus before submitting his report.

Television Station for Cumberland

The B.B.C. announces that a site at Sandale, 1,200ft above sea level and some 14 miles south-west of Carlisle, has been chosen for the projected medium power television station in Cumberland. The new station is expected to be ready for service before the end of 1957; it will bring the B.B.C.'s television service to the greater part of Cumberland and Westmorland as well as to the coastal areas of South-West Scotland. The site will also be suitable for v.h.f.(f.m.) transmissions of the Home, Light and Third programmes when it becomes possible to extend this system to this part of the country.

Industrial Accident Prevention

The Industrial Safety Sub-Committee of the National Joint Advisory Council in its report published on 15th May (H.M. Stationery Office, 1s 6d) states that the total number of days lost to industry on account of incapacity of insured workers through industrial injuries is little short of 20 million man-days a year. The accident rate has changed little in recent years. Only one in every six reported accidents is caused by power driven machinery.

The Sub-Committee says that there is need for more vigorous and better organised efforts to prevent accidents on the part of managers, supervisors and workers, and also technicians, planners, designers and research workers, and it suggests ways in which further organised action can be taken to secure greater freedom from industrial accidents. The report emphasises the importance of effective enforcement of the law through inspection and the need for factory legislation to keep abreast of industrial developments. It recommends that the Factory Department of the Ministry of Labour should be the recognised national and local clearing-house for information on industrial safety and that its advisory services should be expanded and improved.

The appointment of a Standing National Committee to keep under review progress in furthering all aspects of industrial safety is recommended. The National Joint Advisory Council has decided that such a Standing Committee should be set up and that membership should consist of three representatives of the British Employers' Confederation, three representatives of the Trades Union Congress General Council, one representative of the Boards of nationalised industries with a chairman and secretary from the Ministry of Labour and National Service.

Americans Secure Snowy Mountains Contract

Reuter reports from Sydney, N.S.W., that an American firm, Kaiser, Walsh, Perini & Raymond, has been awarded a contract for the Adaminaby Dam which is a part of the Snowy Mountains hydro-electric scheme. The contract is said to be worth £4,291,376 sterling. Mr. McGrath, N.S.W. Minister of Works, said that the tender of the American firm, which is already engaged on other work in the scheme, was the lowest received.

Interchange of Students

The eighth annual report of the International Association for the Exchange of Students for Technical Experience (secretary, Mr. J. Newby,

These photographs were taken during the recent visit to Russia of delegates from the C.E.A. and Area Boards. The left-hand picture includes Messrs. D. P. Sayers, J. Bird, D. B. Irving, N. F. Marsh and R. J. Rennie. The group in a thermodynamics laboratory (right) includes Mr. J. F. Elphick, Mr. F. Shakeshaft, Lord Citrine, Mr. F. J. Lane and Mr. C. T. Melling

Imperial College, South Kensington, London, S.W.7) shows that there are now 21 member countries and 34 British universities and colleges co-operating. It is anticipated that 800 British students will be sent abroad during the coming summer vacation and a corresponding number will come to this country. The report includes the names of firms in the various countries which participate in the scheme; the lists contain strong electrical elements.

Electric Furnace for Bolivia

A Birlec "Lectromelt" furnace is to be supplied to the Corporation Minera de Bolivia at Catavi, Bolivia (an enterprise owned by the Bolivian Government), for making steel castings. The furnace, of 3-ton capacity with a rating of 1,500 kVA, is to be built 12,280ft above sea level. At this elevation cooling of the various motors and ancillary equipment is less efficient than at normal levels and consequently special precautions are to be taken.

Fishing Made Easy

Kelvin & Hughes, Ltd., are now producing a simulator for use with their "Kingfisher" echo sounder. This sounder is being extensively fitted in a wide variety of fishing vessels, especially in the deep water trawlers for which it was designed. Although the equipment is simple in operation users have to be taught how to recognise the fishing echo traces and the simulator has been produced to show them every type of echo response that might be expected on a fishing operation, without the need to make a trip to sea. The equipment is housed in a rectangular case approximately 2ft high and 1ft square, containing the electronic circuits, and the facilities available include simulated variations in bottom contour, hard and soft bottom conditions and single fish or shoal echoes at any selected depth. Various types of interference conditions can be superimposed. The equipment will soon be available at the principal fishing ports.

Design Centre Magazine

This month's special issue of "Design," published by the Council of Industrial Design, contains an eight-page supplement illustrating the opening of the Design Centre by the Duke of Edinburgh at 28, Haymarket, London, on 26th April, and a review of products now on show at the Centre. Representing approximately a tenth of the total number of exhibits, the photographs include electrical and gas appliances, lighting fittings, radio and television sets and clocks. The publication, No. 89, may be obtained from booksellers, price 2s 6d.

Spark Erosion Machining

In view of the increasing interest in machining by the spark erosion method, Burton, Griffiths & Co., Ltd., have brought into operation a mobile demonstration unit for the convenience of those unable to attend demonstrations of "Sparcatron" equipment at the Mackadown Lane Works, Birmingham. Power for the unit is taken, in most instances, direct from the supply of the factory being visited, but there is a self-contained generating set in the van.

Railway Signal Engineering

To help the recruitment of technical staff required in connection with the railway modernisation plan the British Transport Commission has issued a booklet, "Railway Signal Engineering as a Career." There are illustrations of various classes of craftsmen and engineers at work in their particular fields. In the introduction it is said that "signal engineering to-day can be described briefly as a form of light electrical engineering where mechanical knowledge is also of great value and which calls for ingenuity, imagination and a sound knowledge of engineering principles rather than high mathematical ability." The text is sectionalised under such headings as: What is the Railway Signal Engineer's Job?; Who Does the Job and How is it Organised?; and What are the Opportunities and Qualifications for Advancement?

Atmospheric Pollution

The Year Book, 1956, of the National Smoke Abatement Society is now available from its Central Office, Palace Chambers, Bridge Street, London, S.W.1 (64 pages, 1s). It contains, in addition to the annual report, which gives an account of the inception of the Clean Air Bill, a section devoted to general information on matters relating to air pollution. Among the items dealt with are recent papers and reports on the subject, summaries of the work of the Fuel Research Organisation (D.S.I.R.), of the National Industrial Fuel Service and of the present legal position. The membership of the Society now includes over 500 local authorities in addition to other bodies and individuals.

P.O. Electrical Engineers' Journal

During the 1956-57 session the Institution of Post Office Electrical Engineers will celebrate its 50th anniversary. The October issue of the *Post Office Electrical Engineers' Journal* will be a special issue devoted to articles reviewing the development and growth of the British Post Office telecommunications services and the mechanisation of postal services.

Human Aspects of Industry

The Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire will take place at Oxford from 9th to 27th July. The Duke will give his presidential address in the Sheldonian Theatre on 9th July and will preside at the opening and plenary sessions at Rhodes House and the two Conference dinners in Christ Church. Some 300 people in manager/employer and trade union/operative roles of industry will attend the Conference, including 138 from countries in the Commonwealth and 52 from Colonial territories; 29 countries and territories will be represented. The working units of the Conference will be 20 study groups of 14 members, each of which will make an independent tour to an industrial centre and to London. Two of the group chairmen are Mr. R. Telford (general works manager, Marconi's Wireless Telegraph Co., Ltd.) and Mr. S. F. C. Whitmore (manager, Chilterns Sub-Area, Eastern Electricity Board).

Exhibition Poster Competition

It has again been decided by the Exhibition Organising Committee to run an open competition for a poster in connection with the Sixth A.S.E.E. Electrical Engineers Exhibition to be held at Earls Court from 9th to 13th April next year. Cash prizes will be awarded to the best three entries by an adjudicating panel. Designs from students and amateurs will be particularly welcome. Further information can be obtained from the general manager, Electrical Engineers (A.S.E.E.) Exhibition, Ltd., 6, Museum House, 25, Museum Street, London, W.C.1 (telephone: Museum 3450).

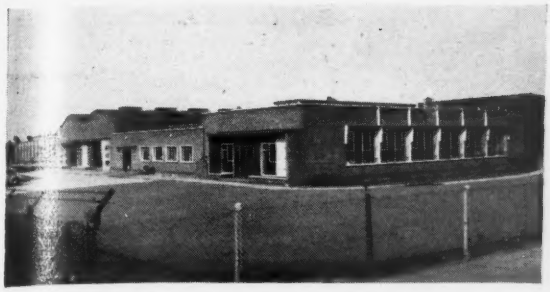
Prices of Materials

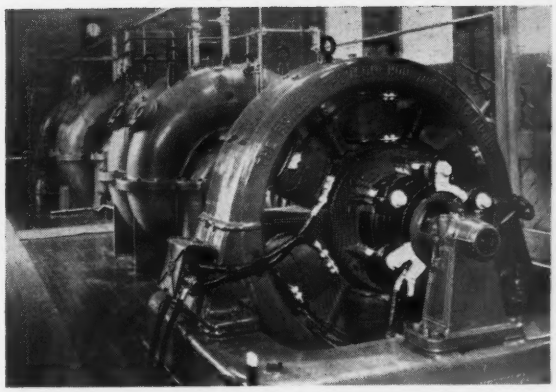
In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £189 0s 0d
COPPER, H.C. Electro	ton £343 5s 0d
Fire Refined 99·70%	ton £342 0s 0d
Fire Refined 99·50%	ton £341 0s 0d
COPPER Tubes ..	lb 3s 3¾d
Sheet	ton £415 5s 0d
H.C. wire and strip ..	ton £382 10s 0d
LEAD, English ..	ton £113 10s 0d
Foreign	ton £112 0s 0d
MERCURY	flask £86 15s 0d
TIN, block (English) ..	ton £751 15s 0d
ZINC, G.O.B. Foreign	ton £95 15s 0d
Electrolytic	ton —
BRASS TUBES (solid drawn)	lb 2s 7¾d
Sheet	ton £328 0s 0d
Wire	lb 3s 3½d
PHOSPHOR BRONZE Wire	lb 4s 10¾d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 24¾d—24½d

Electricity in Building

A conference and exhibition on electricity in building, arranged by the North Western Electricity Board, was held in the Assembly Room, Town Hall, Kendal, on Tuesday and Wednesday this week. On the first day of the conference Mr. A. F. S. Wright (Gauldie, Hardie, Wright & Needham, Dundee) spoke on electric floor warming systems, their design, installation and running costs, and on the second day there was a discussion





Above: New extension to the head office and works of Black & Decker, Ltd., at Harmondsworth. Right: B.T.H. motors which have been in operation at Middlesbrough pumping station since 1915

on electricity in housing, which was opened by Mr. L. L. Williamson (Thomas Armstrong, Ltd., Cockermouth), and Mr. A. O. Johnson (chief commercial officer, North Western Board). Special features of the exhibition were economic wiring practice, built-in supply positions, heat pumps giving hot water and cool larders, and electric floor warming.

Black & Decker Extension

A new extension to the head office and works of Black & Decker, Ltd., at Harmondsworth has just been completed. The original building, erected in 1940, has now been structurally extended by building on to it at two adjacent sides. Besides extending the production space, Black & Decker have made other necessary additions to the building as a whole. The main administration block, which runs along one side of the production area, has been extended. At the west side of the factory a new polishing shop and a new canteen have been erected adjoining the main structure. The electrical services throughout the production area are carried below the roof in continuous trunking hung from the trusses. The main contractors for the extension were W. S. Try, Ltd., and the sub-contractors for electric lighting fittings were the British Thomson-Houston Co., Ltd.

Electronic Course at Harwell

The Atomic Energy Research Establishment, Harwell, is holding its eleventh specialised course on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry, and on work with radioisotopes at Harwell, from 11th to 15th June.

Industrial Art Bursaries

A number of Industrial Art Bursaries are again to be awarded, by competition, by the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. The travelling bursaries, which are usually of £150 each, are open to students intending to take up industrial design as a career. The list of subjects of design for which awards are made includes domestic electrical appliances and electric lighting fittings. The closing date for entries is 15th October and details may be obtained from the Society.

Long-Service Motors

The right-hand picture above shows two motors made by the British Thomson-Houston Co., Ltd., which have been in service at the Snowdon Road pumping station, Middlesbrough, since 1915. They are two of three 220 h.p. 340 r.p.m., d.c. machines, each driving a Gwynnes centrifugal pump for a combined sewage and surface water system. The borough engineer of Middlesbrough says that they appear to be fit for many more years' service.

Computer for King's College

Short Brothers & Harland, Ltd., have recently delivered an electronic analogue computer to the Electrical Engineering Department of King's College, London. The machine will be used for research purposes, principally in the fields of electrical circuit problems and non-linear problems. It will also be used for post-graduate training.

Heat Treatment Conference

A conference on heat treatment practice, organised by the Metallurgy (General) Division of the British Iron & Steel Research Association, is to be held at Ashorne Hill, near Leamington Spa, on 5th and 6th June.

Application forms for the conference and full details of the arrangements can be obtained from the organiser and secretary, Mr. J. R. Powell, of the British Iron and Steel Research Association, 11, Park Lane, London, W.1.

"Self-Insulating" Aluminium Wire

A correspondent writes that the Aluminum Company of Canada, Ltd., has developed a new process of anodising aluminium wire with alternating current to give it a ductile oxide coating which, in effect, becomes an electrical insulation, thus opening "completely new horizons in design" to electrical equipment manufacturers. Electrical equipment wound with light, heat-resistant aluminium wire—instead of heavier copper wire—could be made smaller, cheaper and lighter, and could be operated at higher temperatures, it is claimed.

The process involves pulling the aluminium wire through tanks containing chemical solutions which quickly give it a thin, hard coating. In eighteen months of research the engineers devised a process capable of providing an insulated film at commercial speeds and developed an anodic film sufficiently ductile to withstand the stressing and flexing operations involved in winding electrical coils.

Cooker Order from Singapore

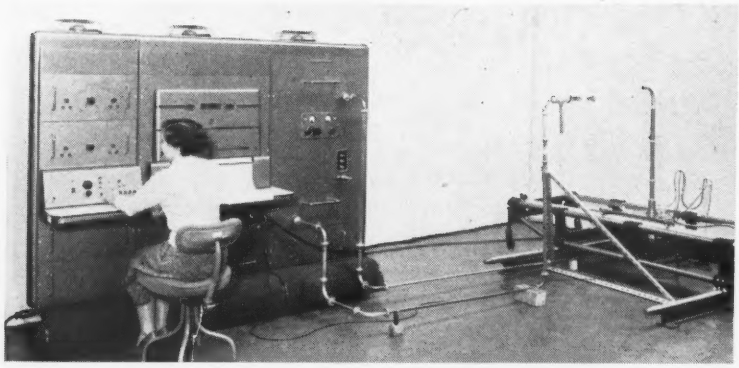
A large order for domestic electric cookers has been placed by Singapore City Council with the General Electric Co., Ltd.; it is valued at over £100,000 and is for 5,000 cookers. Four thousand of these cookers will be standard British models and the other thousand will have hobs specially adapted to Eastern needs; the griller will be omitted and two of the hotplates specially scooped to take the convex Kwali rice dish, traditional Malayan cooking utensil. The cookers will be built in the company's cooker works at Swinton, near Mexborough, Yorkshire.

Export Credits Guarantee Department

The headquarters address of the Export Credits Guarantee Department is now 59, Gresham Street, London, E.C.2 (telephone: Monarch 6699). The Department has been in Clements Lane since 1927; for the last sixteen years, however, some sections have had to be accommodated in outlying buildings. At present it occupies four buildings distant from each other as much as 1½ miles. The new move brings all sections once more under one roof.

Motors for Ships' Auxiliaries

Laurence, Scott & Electromotors, Ltd., have supplied a large number of electric motors for auxiliaries on the *Spyros Niarchos*, a 47,000 ton tanker, and the 20,000 ton Cunard liner *Carinthia* which will go into service shortly. For the former vessel about fifty electric motors and one 150 kW



Elliott aerial testing instrument in use

auxiliary alternator (Davy Paxman engine) have been supplied. For the *Carinthia* 125 motors totalling over 4,000 h.p. have been supplied as well as "Scott" cargo winches.

Testing Micro-Wave Aerials

An automatic instrument for the testing of micro-wave aerials has recently been completed at the laboratories of Elliott Brothers (London), Ltd., Elstree Way, Borehamwood, Herts. This is designed for testing the aerials used on the very short wavelengths of most modern radio and radar equipment. Included is an electrically driven gantry whose position can be continually measured and automatically recorded, while moving, with an accuracy of a few thousandths of an inch throughout its 6ft traverse. The first model has been delivered to the Admiralty Signal & Radar Establishment at Portsmouth.

Award for "SeaBoard"

The South Eastern Electricity Board magazine, *SeaBoard*, has won a certificate of merit in the 1956 national house journal competition organised by the British Association of Industrial Editors. *SeaBoard* is edited and produced by John Boyle, of the Secretary's Department, who has been elected vice-chairman of the Association.

E.M.I. College of Electronics

The department of E.M.I. Institutes which provides full-time day courses in radio and electronic engineering will in future be known as the E.M.I. College of Electronics. To-day over 200 students are attending the various full-time courses offered by the College, and in addition, a large number of qualified engineers and physicists are receiving part-time post-graduate training.

Wolf Electric Tools Expansion

In order to deal with expanding business in the Midlands, Wolf Electric Tools, Ltd., has purchased the property adjacent to its Birmingham Sales and Service Branch at 47, Barker Street, Birmingham, 19. The acquisition of this property will enable the existing showroom to be expanded, and it is planned, in addition to industrial and "Cub" portable electric tools, to install a complete range of Wolf transport service equipment for demonstration purposes. The Branch (telephone: Northern 3938/9/30) is managed by Mr. P. Frost.

Toy Factory Installation

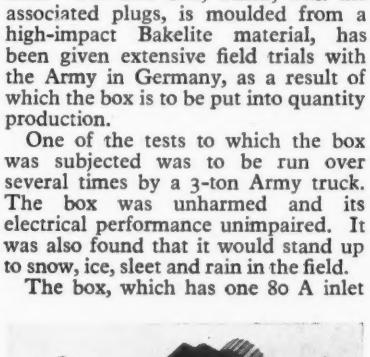
H. F. Scriven, Ltd., Hitchin, inform us that they have recently completed the electrical installation in the new factory of Ludun, Ltd., Dunstable, which will employ disabled persons in the manufacture of toys, garden furniture, etc. The factory is to be opened by the Duke of Edinburgh on 30th May.

Heavy Duty Junction Box

The Witton Moulded Insulation Works of the General Electric Co., Ltd., have produced for the Army a plastics junction box capable of withstanding the roughest treatment and extreme climatic conditions in the field. The new box, which, with the associated plugs, is moulded from a high-impact Bakelite material, has been given extensive field trials with the Army in Germany, as a result of which the box is to be put into quantity production.

One of the tests to which the box was subjected was to be run over several times by a 3-ton Army truck. The box was unharmed and its electrical performance unimpaired. It was also found that it would stand up to snow, ice, sleet and rain in the field.

The box, which has one 80 A inlet socket, one 80 A outlet socket and three 13 A outlet sockets, is capable of distributing 10 kW of lighting load, sufficient for the dugouts and tents of a divisional headquarters in the field. The supply is normally taken from a 27·5 kVA generating set, the distribution panel on which carries socket outlets and plugs moulded from the same high-impact Bakelite material as the junction box. These comprise altogether six 80 A single-pole outlets and plugs, four neutral points and plugs and two 13 A socket outlets.



Army junction box moulded from high-impact Bakelite material

Trade with Brazil

In 1955 Brazil exported goods to Great Britain to the value of £31,804,000 but imported British products to the value of only £6,562,000. The *Brazilian Bulletin* (published by the Brazilian Government Trade Bureau in Great Britain, 157-161, Regent Street, London, W.1) shows that the imports included generating sets, generators and motors valued at £110,000; telegraph and telephone equipment and line apparatus for long distance communication £291,000; and other electrical machinery and apparatus £390,000.

Industrial and Factory Law Course

A course of lectures on industrial and factory law will be given by Mr. Harry Samuels at Robert Hyde House, 48, Bryanston Square, London, W.1, from 29th to 31st May. Further particulars can be obtained from the secretary of the Industrial Welfare Society, Robert Hyde House, 48, Bryanston Square, London, W.1.

Vancouver Island Power Link

In the article under the above heading in the *Electrical Review* of 11th May in references at the beginning and towards the end of the article the cable ship employed for the laying of cables between the mainland of British Columbia and Vancouver Island was called the *Ocean Monarch*; the correct name of the vessel is the *Ocean Layer*.

Trade Announcements

The Simplex Electric Co., Ltd., has opened new West End offices and showrooms at Creda House, 26-28, Binney Street, off Oxford Street, London, W.1 (telephone: Grosvenor 6951). Trade inquiries for Simplex and Creda products should continue to be addressed to 217-219, Tottenham Court Road, W.1 (telephone: Museum 1500).

Phillips & Bonson, Ltd., now have an arrangement with Barnett Shipping & Export Co., Ltd., of St. Magnus House, 25, Monument Street, London, E.C.3, whereby the latter company is now handling the export of "Sinfonia" and "President" tape recorders and high fidelity amplifying equipment.

The office, stores and trade counter of **Progress Cables (Kent), Ltd.**, are now at 7 & 8, Chieveley Parade, Mayplace Road East, Barnehurst, Kent.

How Low is a Safe Voltage?

A CRITICAL EXAMINATION OF PORTABLE TOOL SAFETY TECHNIQUES

By
T. C. Gilbert,
M.I.E.E.

IN the annual report of the Factory Department of the Ministry of Labour and National Service for 1954 the Chief Inspector again advances the plea for the use of low voltage in connection with the rapidly extending use of portable tools, and calls attention to the high proportion of accidents associated with the use of 240 V in the usually hazardous surroundings of a factory. The installation of low voltage distribution is recommended when new factories or extensions are being made, with transformation down to 110 V and secondary mid-point earthed, so that the user of portable tools is exposed to nothing higher than 55 V in the event of leakage.

It is said that this can be done with a comparatively small increase in capital cost, but is this so? Most estimates made by the writer for substituting low voltage circuits for portable tools in place of the usual run of 240 V socket-outlets have been illuminating; it is not only a case of doubling the circuit conductors to take care of the increased currents required, as other factors have to be taken into account. For instance, a 100ft run (200ft of conductor) in 3/·036 cable can be loaded to its full 15 A with a volt drop of 10 V, which would be permissible for 240 V tools, but 110 V tools can be allowed only half this drop, and the 100ft run carrying equivalent power at 110 V would need to be 7/·052, nearly five times the size of the 240 V conductor, with a corresponding increase in conduit sizes.

It is known that the individual factory inspectors and many eminent engineers in private practice favour the use of low voltage for portable tools, and one recognises the authority and wide experience behind these views. But the writer has long held the view that when all relevant practical aspects of the proposal are considered it will be seen that the suggestion to use 110 V goes only half way towards securing that degree of safety desirable in the factory, and there are alternatives. The use of 110 V with the secondary centre tapped and earthed does not really achieve safety for the simple reason that at this voltage the vulnerable earth conductor in the flexible lead must be retained, and without expensive and complicated additions there are no means of ensuring that this conductor remains intact. With the loss of this essential link in the safety chain the 110 V tool would appear to be no safer than the 240 V tool, in fact, the writer would say that it is less safe, for with a 240 V tool there is risk of shock from the phase line only, but with a 110 V tool supplied under the conditions visualised there is a potential difference of 55 V on both leads against earth, there being no phase and neutral as such. The chances of shock are therefore doubled, and it is thought that nobody will claim that 55 V a.c. is safe, especially in view of the fact, often overlooked, that the relatively wide regulation of small transformers, and particularly those capable of withstanding short-circuit of their secondaries, affords an appreciably higher open-circuit voltage than 55 V to which an operative might be exposed.

The Chief Inspector's report for 1951 made the same point of using low voltage, but stated: ". . . and although there are some cases of special risk—such as arise in boilers or tanks—where a reduction to a still lower voltage is desirable, experience appears to justify the figure of 110 V as a sound compromise for general use." This leaves one with the uncomfortable feeling that with the use of 110 V we have not gone very far towards real safety, as certainly 55 V to earth is too high for the situations stated and also for general use in such places as shipyards. The all-insulated handlamp is not looked upon with favour, as it does not appear capable of withstanding rough treatment whilst cordgrips do not prove effective against the pulling-out of conductors under strain, and the considerations mentioned have led many engineers to favour the idea of using two low voltages, employing 50 V (25 V against earth) for all handlamp socket-outlets in the more hazardous situations and higher voltages for the "earth-free" areas. It is doubtful if the average user can be trained to differentiate between hazardous and less hazardous situations, and it is too much to expect him to change his handlamp when passing from the one to the other. Unless, therefore, two low voltages are to be used throughout the factory it is my view that the lower voltage must be adopted, that is, providing for the use of 50 V tools ensuring no more than 25 V a.c. against earth at any point.

It is thought that the authorities mentioned are themselves not too happy about the 110 V proposal, as in a series of articles on earthing in the technical Press Mr. F. H. Mann, M.I.E.E., until recently the Chief Electrical Inspector of Factories, said: "Safety in the use of portable apparatus is best secured by recourse to a voltage substantially less than that of the mains, and if a value is selected such that the shock risk to earth does not exceed about 25 V it is in some cases possible to dispense with the earth connection." This, it is thought, is the real seed of safety—the elimination of dependence upon an earth connection under all conditions; this postulates the use of 50 V tools, and these are freely available, being very robust and remarkably free from winding faults. Both weights and power consumptions are only slightly higher for the 50 V tools than for the 240 V, but the use of the larger tools is practically prohibited; for instance, a 1in heavy drill would need a twin-core flexible lead of 195/·010in, and a 30 A socket and plug, the full load current being about 35 A.

Individual Transformers Required

Although the use of 50 V tools would undoubtedly achieve a very high level of safety it at once raises serious economic considerations; obviously the great disadvantage of a 50 V supply is the unavoidable voltage drop at points of application. Most portable tool manufacturers recommend that their products should be operated within 5 per cent of their nominal voltage, and thus on a 50 V supply the permissible circuit drop would be no more than 2·5 V against 12 V for the 240 V tool. With operating currents five times as great it is clear that to obtain the same percentage drop on 240 V and 50 V cables of the same length and transmitting the same power the cross-sectional area

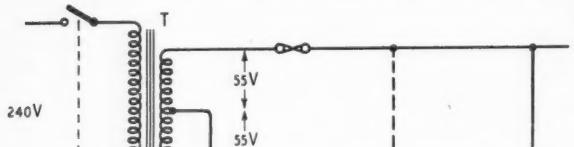
of the 50 V cable would need to be at least 25 times that of the 240 V cable. As this is economically impracticable, users of 50 V tools would have to use individual fixed or portable transformers at the 240 V supply points.

With a hundred 50 V points throughout a factory 100 transformers would be required, of varying sizes and costs; the alternative is to use a smaller number of portable transformers. This the writer has always deprecated, except possibly as a temporary measure during change-over to low voltage, for at best the portable transformer is just another piece of portable equipment, needing protection almost as much as a tool, and also, under Factory Regulations, an earth connection to the transformer core, even if wood-cased. A 500 VA transformer might weigh 30 lb but still be inadequate for the larger tools, say a 1in drill or a 4in grinder, but the dragging of even this weight nearer the work might easily result in a disturbance of the connections; the temporary extension of leads is nearly always made on the 240 V side, and the earth connection may or may not be maintained. In addition, the mere existence of the 240 V supply points will be a source of danger.

Earth-Leakage Protection

If these points be accepted it would appear that 110 V does not achieve any real level of safety as 55 V against earth is still too high for some situations, and in all cases the vulnerable earth connection is still required. If reduction be made to 50 V economic considerations appear to be insurmountable, unless the system is limited to a small area in a factory with sockets close to the work and fed by a large transformer. As all accidents are the combination of two main factors, voltage and time, if we are not able effectively to deal with the voltage element, why not concentrate upon the time factor? If disconnection of a leaky tool can be made in, say, a fraction of a second, it would not seem to matter what the voltage might be to which the user is exposed. This aspect of the problem has received some attention by factory inspectors in connection with the well-known Butcher system, with which the standard 240 V supply is transformed down to 110 V, but the centre-tap of the secondary winding is not taken direct to earth but via the tripping coil of a standard earth leakage circuit-breaker; this simple arrangement is shown in the diagram.

Excellent as this system is, the writer feels that it is only another half-way house, and we need to go further. It is pointed out that, with this system, tripping under earth fault will depend upon a voltage of no more than 55 V to earth under the best conditions, and might well be much less. The tool may be under load when the fault develops,



Butcher earth-leakage protective system

T, transformer. ME, main earth. TC, e.l.c.b. trip coil in earthed secondary tap connection, TE. TB, test or stop buttons. A, appliance. *Note.*—In some applications of this system the low-voltage side is opened by the operation of the e.l.c.b, but the above arrangement isolates the transformer as well as the low-voltage circuits

or other tools may be operating on the same circuit—the Butcher system is usually applied to groups of tools—so that the circuit voltage drop might be considerable, with no more than 45-50 V available for tripping. Depending upon the impedance of the earth continuity conductor and the earth electrodes—consumer and supply—a low operating voltage might leave the circuit-breaker on the threshold of operation, and even if isolation were not prevented it might be delayed, which, in my view, is equally serious. Marginal operation of the protective devices should not be acceptable where matters of safety are involved.

Tests show that 240 V applied directly across the trip coil of the e.l.c.b., ignoring all exterior impedances, causes operation within 6 milliseconds, less than a half cycle of the supply frequency; on the other hand the application of 45 V delays operation for 24 milliseconds. It might be thought that 0·024 second is fast enough in all conscience, but bitter experience has taught us that always in the background lurk those three spectres—high impedance in the fault, the earth continuity conductor and the electrode, possibly all three together and all unpredictable. We are therefore faced with the apparent paradox that the higher the leakage voltage the faster and more certain is the operation of the protective device, and therefore the greater the safety.

In the matter of fault impedance there is one practical point that should be given serious consideration. Most of the smaller and more popular tools are a.c./d.c. series wound, with the brush gear placed between the two field coils; 75 per cent of faults occur on brushes and brush holders, and should a fault be to the frame, due to accumulations of conductive copper and other dust across the short insulating paths, one field coil must always remain in the earth-fault current path, offering considerable impedance. It is certain that under such conditions, with only 55 V against earth, the circuit fuses would not be blown, and it is possible that the Butcher system e.l.c.b. would not operate either, especially if the actual fault, and electrode, plus the field coil, offered a high combined impedance; on the other hand, with 240 V against earth, these combined impedances could be overcome.

Before small leakage trips can be tried out for group or individual socket-outlet protection—they are now available in 15 A sizes with or without a 13 A socket-outlet on the same plate—it will be necessary to secure some relaxation of the Factory Department's requirement for a direct earth connection in parallel with the trip earth. This requirement has been justified on various grounds, but is, in my view, foreign to the real conception of protection by leakage voltages; in theory the leakage trip backs up the direct earth, but in practice the incidence of fault impedance plus the shunting of the trip by comparatively low impedance direct earth connections distorts efficient protection, and may introduce the menace of marginal operation. It will be noted that in the Butcher system this direct earth connection is applied to the core of the transformer, and does not anywhere enter into the secondary side where the leakage trip is connected, and where any parallel earth connection would certainly complicate operation, probably resulting in the shifting of protection to the circuit fuses, which, as has been shown, might not operate under the commoner faults; certainly it would preclude the simple earth continuity test shown in the diagram. It might be said that factory owners have been prevented from enjoying the benefits of voltage-operated leakage protection by the parallel earth requirement; certainly there is no wide industrial experience to call upon, as is the case with domestic applications of the method.

A point worthy of serious consideration is that small leakage trips at all 240 V socket-outlets for the use of

portable tools could be adopted for all existing factories and works without interruption, modification of wiring, or rewinding of the existing 240 V equipment, but the concurrence of the authorities in getting rid of the parallel earth requirement will be necessary before this can efficiently be done. It is suggested that a trial period might be necessary, not so much to prove the principle as to ascertain if these small mechanisms can, in fact, stand up to industrial conditions with the requisite reliability, or if any modifications are necessary. It will be said that the use of small individual trips again brings the earth conductor into the picture, and this is true, but it is so easily checked; a simple lamp test is all that is necessary, compared with the cumbersome heavy-current tests required with direct earthing, whether at 240 V or 110 V. It is not outside the bounds of possibility to incorporate a small test button actually in the tool itself, where used in the conditions described, and as is done abroad; this enables every operator to check his earth connection and satisfy himself that the mechanism for his protection is working satisfactorily.

Whatever is done in the factory, however, there still remains that wide—and growing—circle of portable tool users, the general public. It is unlikely that any suggestion to use lower voltages would appeal there, and it might after all make for a higher general level of safety if all tools were standardised at 240 V instead of many being produced for lower voltages. Under the wise guidance of his contractor or area board representative the domestic user can immediately apply voltage-operated protective measures in his workshop; it seems a pity that the industrial user, in more hazardous surroundings, cannot do the same.

French Electricity Supply in 1955

FROM A PARIS CORRESPONDENT

DETAILS of the activities of Electricité de France (the French Electricity Board) in 1955 were recently given by Monsieur Robert Renaud, chief engineer, head of the Liaison and Information Mission, assisted by Messrs. Boudrant, production and transport manager, Bardon, assistant manager, and Merle, distribution manager.

M. Boudrant said that in 1955 production reached a total of 49,450 million kWh, an increase of 9.1 per cent over the 1954 figures (following a 7.1 per cent rise in 1954). The maximum daily consumption was 157.6 million kWh and the maximum demand was 8.86 million kW.

The month of November and the beginning of December were very dry and the steam generating stations broke all previous production records (on 7th December steam generating stations produced 110 million kWh out of a total output that day of 157 million kWh) but this high production rate caused a serious run-down of coal stocks at the power stations.

In the second fortnight in December, however, the situation improved; increased water flow made it possible to slow down substantially the production rate at the steam generating stations and partly to restore the fuel stock levels. At the same time the quantities of available water stored in the reservoirs, particularly those in the Massif Central, represented a supply of over 300 million kWh.

During this year, with the six new steam turbo-alternator units of 110,000 kW capacity (two at Creil, two at Porcheville, one at Gennevilliers, and one at La Bassée, near Lille), Electricité de France hopes to be able to meet a peak demand of about 10 million kW.

Water storage in 1955 was about 95 per cent of normal. Catchment areas in the Alps and Pyrénées remain constant and regular and the working of reservoirs in these regions seldom varies from one end of the year to the other. But the Massif Central is full of surprises and the storage is apt to vary considerably.

The French iron and steel industries and collieries are self-supporting in the matter of electric power, their production being sufficient to cover their total requirements, and the surplus output is sold to Electricité de France. The iron and steel industries are more or less balanced but the collieries sold to E.D.F. and its subsidiaries 5,100 million kWh of surplus power above their own consumption of 3,700 million kWh; in other words, their steam power production was 8,800 million kWh, slightly more than the steam power production of the E.D.F. itself, which was 8,750 million kWh.

M. Merle, dealing with production and consumption of power, said that low voltage supply reached in 1954 (the last year for which statistics are available) 7,060 million kWh (i.e. 15.5 per cent of the whole French consumption) distributed as follows:—Domestic lighting, 1,850 million kWh; other domestic uses, 1,900 million kWh; commercial lighting, 940 million kWh; motive power and other uses, 2,370 million kWh.

The E.D.F. system now includes 1,950 transformer stations connecting the main distribution lines to the medium voltage networks; 285,000 km of medium voltage lines which supply the low voltage distribution networks as well as some of the high voltage users; 163,000 distribution points between the medium voltage and low voltage networks; and more than 400,000 km of l.v. lines. Between 1947 and 1955, nearly 80,000 km of medium and low voltage lines and nearly 19,000 distribution points were installed or strengthened (not including work for which rural communities were responsible).

M. Merle said that the rate of increase of power consumption was some 11 per cent yearly. The trend of sales of domestic electrical appliances now showed a clearly marked progress in certain items. It was considered of the greatest importance not merely to maintain the present rate of development, but also to increase investment of capital in distribution networks.

Clean Air

IN the Spring Issue of *Smokeless Air* (the journal of the National Smoke Abatement Society) particulars are given of amendments to the Clean Air Bill proposed or supported by the Society. Among those accepted are a requirement that local authorities must be given prior notification of all new industrial fuel-burning plant and that the Clean Air Council shall be a statutory body. The capacity of plants above which the use of grit arrestors is required has been reduced from ten tons an hour, as originally proposed, to one ton. Other articles relate to a new U.S.A. ordinance dealing with air pollution from steel plants, the washing of power-station flue gases, and means of securing smoke reduction and fuel efficiency by measurement and control.

Scientific Instrument Design

Survey of the Physical Society Exhibition

By P. L. DEGEN, B.Sc.(Hons.)

THE exhibition of scientific instruments and apparatus which has just concluded was the fortieth in the series organised each year by the Physical Society. This was the second year since the move from the Imperial College of Science and Technology, and the available area was increased over that of last year by spreading the exhibition over both the old and new halls of the Royal Horticultural Society, which avoided the previous congestion. The exhibition, which ran from 14th to 17th May, was formally opened by Sir John Cockcroft, K.C.B., K.B.E., F.R.S., director of the Atomic Energy Research Establishment, Harwell.

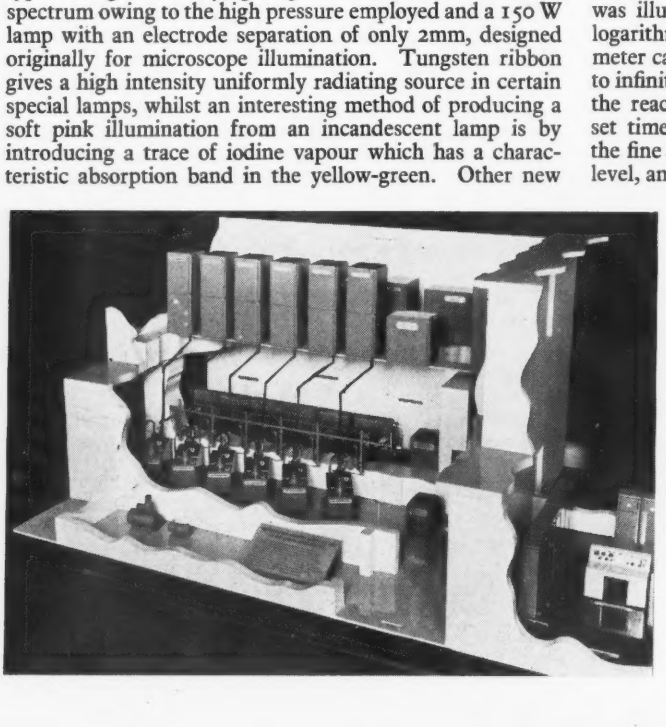
As usual, there were discourses and demonstration lectures during the course of the exhibition. One lecture was on "The Production of Images of Chemical Molecules" by Professor Lipson, describing a method of projecting a pattern of light computed from X-ray diffraction studies on a crystalline substance. Optical interferences between the different light beams of the pattern produce an image of the structure of the molecule. In another lecture Mr. G. G. Gouriet, B.B.C. Research Laboratories, dealt with compatible systems of colour television.

Mr. H. G. Jenkins of the G.E.C. Research Laboratories spoke on "Recent Developments in Light Sources." He discussed the four main categories of electric light source currently available, viz. incandescent filament, fluorescent, h.p. mercury vapour discharge and sodium vapour. Illustrating his remarks in the exhibition proper were a range of h.p. m.v. lamps including a water cooled 500 W type of high intensity, giving a considerable continuous spectrum owing to the high pressure employed and a 150 W lamp with an electrode separation of only 2mm, designed originally for microscope illumination. Tungsten ribbon gives a high intensity uniformly radiating source in certain special lamps, whilst an interesting method of producing a soft pink illumination from an incandescent lamp is by introducing a trace of iodine vapour which has a characteristic absorption band in the yellow-green. Other new lamps included a tubular quartz source of visible, ultra-violet and infra-red radiations, a high speed stroboscopic light source capable of operation up to 30 kc/s, and several spectral line sources.

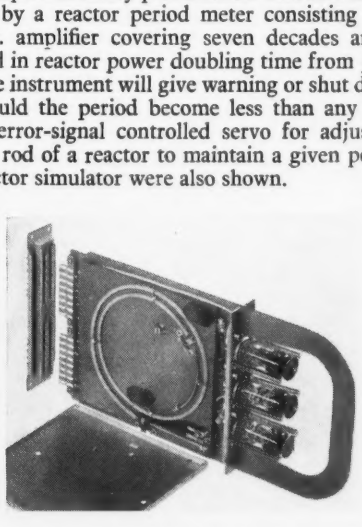
A considerable number of the exhibits were described as equipment for nuclear instrumentation, many of them having been developed in conjunction with Harwell. They included a pulse amplitude analyser with a resolving time of 500 μsec for the measurement of the amplitude distribution, either of pulses produced by any type of nuclear counter, or of any other quantity which can be fed into the instrument in the form of variation in pulse height. A pulse amplifier with band width up to 2 Mc/s is intended for use with ionisation, proportional and scintillation counters. An alternative method of detection is to measure the direct current through an ionisation chamber, and a micro-micro-ammeter was exhibited which incorporates a sub-miniature electrometer triode and two magnetic amplifier stages. It has six current ranges from 10^{-11} to 10^{-6} A and will drive a pen recorder and with further magnetic amplification give warning if the current exceeds a pre-set level.

Radioactive Dust Measurement

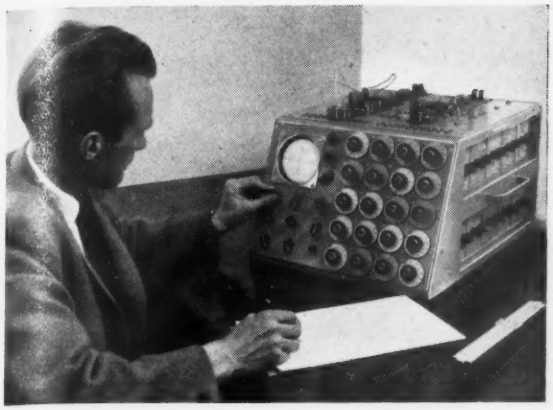
A twin-channel monitor measures atmospheric contamination by dust particles containing long-lived radioactive elements, such as uranium and plutonium, in the presence of rapidly decaying and hence intensely emitting products such as radon. This, together with a contamination monitor for hands and clothing, and a laundry monitor, illustrated one aspect of safety precautions. Another aspect was illustrated by a reactor period meter consisting of a logarithmic d.c. amplifier covering seven decades and a meter calibrated in reactor power doubling time from 5 sec to infinity. The instrument will give warning or shut down the reactor should the period become less than any pre-set time. An error-signal controlled servo for adjusting the fine control rod of a reactor to maintain a given power level, and a reactor simulator were also shown.



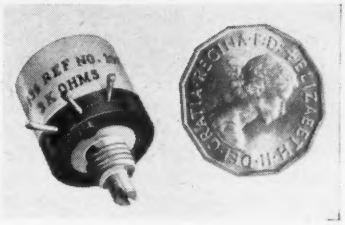
Left: Model of 25 MeV linear accelerator



Above: Short nickel delay line forming a single-word register, together with its recirculating amplifier and control circuits



Above : *Table-top analogue computer*



Right : Linear function sub-miniature potentiometer

A very considerable electronic engineering project in itself is the 25 MeV linear accelerator under construction for use in neutron studies at Harwell. The model on view illustrated this: the six sections are each energised by a klystron amplifier delivering a peak power of 6 MW at 10 cm. The output pulse length and the recurrence rate will be variable between 0·2-2 μsec and 25-750 pulses per second. The average beam power will be 30 kW at 25 MeV.

Another field in which a wide variety of instrumentation and apparatus was exhibited was that of computers. The instruments and accessories on show included a digital computer with only 200 electronic valves; input is by punched paper tape; 16 magnetic cores provide the quick access store; and the main store is a magnetic drum with a capacity of 4,032 words. Other exhibitors showed magnetic drum storage units: one, 10in in diameter, rotates at speeds up to 8,000 r.p.m. and has a maximum storage limit of about 300,000 digits in 100 tracks, whilst another has 112 tracks and 224,000 digits, crosstalk between tracks being less than -44 dB. Another method of information storage in digital computers is the delay line: two devices were shown in which the delay is introduced by transmitting acoustic pulses along a nickel or alloy line with a period of 3 μsec. The smaller unit, intended as an immediate access store, has a capacity of 42 binary digits; the larger unit, intended as a unit in a computer main store, 1,200 binary digits. A punched card reader for digital computers reads from standard 65 or 80 column cards, at rates up to 600 cards per minute by means of a row of photocells, one to each column.

Elsewhere two digitisers were shown: rotation of a shaft is divided in one case into 1,000 increments per rotation with brush take-off; a 10,000 division digitiser employs photocell pick-off.

Analogue computers were represented by an improved model of a small table top computer suitable for educational purposes or for preliminary design investigations, also by a multiplier/divider unit intended for installation in a larger computer. From two time-varying voltages it will produce an output voltage proportional either to their product or ratio. Elsewhere an experimental analogue-digital convertor was demonstrated: the input consists of 25 d.c. voltages and the output is in the form of an electrically typewritten record.

The remote control of machine tools, transmitters and receivers, etc., is possible with high accuracy using autotuners. Three types were shown, one with an accuracy of 3 minutes of arc in 10 turns (1 in 72,000). Another exhibit symptomatic of the trend towards automation was a measuring system for machine tool setting. An electromagnetic gauge head gives a signal dependent on misalignment with an adjacent measuring bar with a sensitivity of 0·00002in, and by means of a servo the cross-slide of a machine tool can be controlled.

Compact Apparatus

The use of transistors together with suitably miniaturised components leads to some strikingly compact devices. Thus a push-pull amplifier is incorporated in a 50 μA moving coil meter to give a final sensitivity of 2 μA, and pocket-sized quartz-fibre dosemeter charging units based on transistor oscillators are driven by 1·35 V or 1·5 V cells. Components of a suitably small size include a range of transformers of novel construction first exhibited last year and since extended; sub-miniaturised, encapsulated circuits; a range of controls and composition track volume controls; and a range of sub-miniature precision wire-wound potentiometers only $\frac{1}{2}$in by $\frac{5}{8}$in diameter, yet of high accuracy. A miniature cable laying machine which manufactures cables from nylon monofilament and copper strands was shown: one type of two way cable produced has a diameter of 0·024in, and the end connectors are all moulded on *in situ*.

In contrast to all these novel developments, a standard capacitance was exhibited elsewhere which, while incorporating recent improvements, is basically a design of long standing. The total capacitance of 1 μF is subdivided by decades to units of 0·001 μF and continuously interpolated by a silica-insulated variable air condenser. Temperature coefficients of the order of 10^{-5}, a power factor varying between 0·00005 and 0·0001, and an accuracy of 0·01 per cent of nominal value, very stable with time, are features of the instrument, which the makers claim to be the finest capacitance in the world.

A similar claim in respect of stability is made for a standard frequency equipment. This is based on work by the Radio Experimental and Development Branch of the Post Office, and incorporates a 100 kc/s crystal oscillator employing an Essen ring type crystal in a temperature controlled oven. The daily stability is better than five parts in 10^{10}. The transistor appears again in a literally pocket-sized communications receiver crystal calibrator. The oscillator stage is followed by a buffer amplifier stage and frequency stability is better than 15 parts in a million per degree C. Fundamental frequencies between 50 kc/s and 2 Mc/s can be obtained and useful harmonics up to 30 Mc/s are available from the shock resistant and moisture-proof potted circuit.

A precision loss measuring set utilises in turn a h.f. attenuator of good frequency/loss characteristic and relatively poor stability and calibration, and an accurately calibrated l.f. attenuator of high stability. The range is 0-80 dB, the absolute accuracy varies from $\pm$0·005 dB at 1 Mc/s to $\pm$0·025 dB between 5-10 Mc/s and the range can be extended at lower accuracy to 10 kc/s and 20 Mc/s. Measurements of the gain and phase change of an amplifier are possible with a phasemeter designed for measurements on two voltages of common origin. The instrument imposes no appreciable load on the circuit under test; frequency range is 2 c/s-100 kc/s and accuracy is $\pm$1 per

cent except in the range 2 c/s-5 c/s where it worsens to ±3 per cent. Used in conjunction with a frequency analyser also exhibited, it enables accurate measurements to be made on distorted wave forms. A laboratory conductance bridge covers from 0·1 micromho to 10 mho in four switched ranges. Balance indication is by c.r.t. display, thus rendering amplitude and phase balancing virtually independent, and the accuracy is ±0·2 per cent at the ends of each range, and substantially better in the middle. An insulation resistance meter covers the range 1-107 MΩ, the value of test voltage applied being variable from 10-1,000 V d.c. Another megohmmeter uses a vibrating condenser unit and will measure up to 10^8 MΩ, with the application of only a low test voltage.

On the same stand was a millisecond timer which combines the ranges of two instruments previously manufactured; eight ranges cover from 0·2 millisec to 10 sec with an accuracy of 1-2 per cent. On another stand a prototype decimicrosecond chronometer was shown. This instrument is based on the crystal oscillator, electronic gate and decade counter arrangement, and the time range is from 0·125 μsec to 1 sec with an accuracy of ±1 in 10^5 ±0·125 μsec.

Equipment and components in the Q band (26·1-39·5 kMc/s: 7·6-11·5 mm) included an electroformed precision waveguide with a cylindrical exterior and internal dimensional accuracy of 0·0001in and a wide range of flanges, connectors and instruments. The enthrakometer indicates incident r.f. power by measuring the resistance of a thin film of platinum which is deposited on a glass plate and arranged across the waveguide to absorb the whole of the incident energy. A prototype test bench was shown for measurements in the 4 mm waveband. A range of resonant cavity wavemeters covers the frequency range from 0·9 to 41 kMc/s (7·3 mm-33 cm) including the S, X and Q bands. Accuracy of frequency measurement is better than 1 in 3,000 and can be increased to 1 in 10,000 if the coupling is suitably reduced.

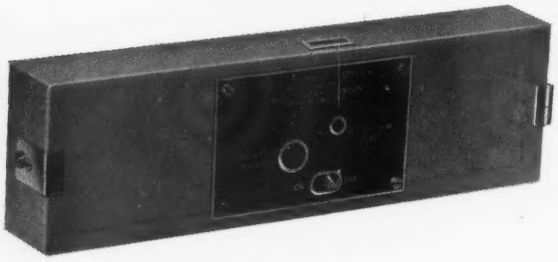
Materials and Techniques

New materials and techniques demonstrated included ranges of microwave absorbing materials. One range consists of foam rubber panels with a cellular profile on the front surface providing a gradual transition from the impedance of free space to that of the highly attenuating material. Absorption of normally incident power varies from 99 per cent in the range 5,000-10,000 Mc/s to 99·7 per cent at 50,000 Mc/s. The other range of materials is designed for specific wavebands and consists of a quarter-wave layer of critical magnetic and dielectric properties backed by a perfect reflector. Materials for the S-band and the X-band have been developed, the power absorption being 99·5 per cent and band widths ±360 Mc/s and ±480 Mc/s respectively.

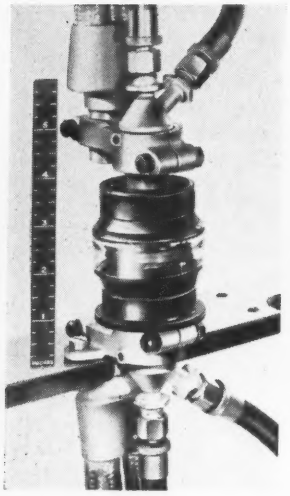
A new technique of producing water-tight, pressurisable lengths of waveguide consists in facing the flanges with indium and pressure welding them together. The technique of producing metal/ceramic seals has been improved so that ceramic valve envelopes are possible. Examples exhibited are designed for the frequency range 200-2,000 Mc/s. A high power water-cooled germanium diode rectifier was shown, which will operate up to 300 A d.c. The junction area is 180 mm^2, and the compactness of the unit can be seen in the illustration. The long established selenium rectifier has been improved by the first production scale application in this country of vacuum deposition of the selenium coating, and increased uniformity and life are claimed.

Magnetic alloys under development include improved Mumetal and Radiometal, and the high saturation induction Permendur and 24 Permandur, which is available in strip up to 6in wide and down to a few ten thousandths of an inch thick. These and other alloys are produced as strip from a mixture of their powdered constituents by continuous compaction, sintering and rolling. Nickel-iron strip produced in this way has such greatly improved consistency of properties that considerable economies in material are possible, and the very thin strip has properties which are sometimes thought to be obtainable only with non-metallic magnetic materials.

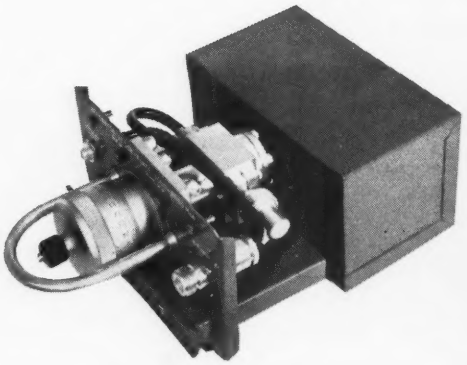
In an ingenious technique for the measurement of a very rapidly varying current (i.e. at rates of the order of 10^6 A per sec) a search coil is arranged so as to form a mutual



End-of-film and footage indicator



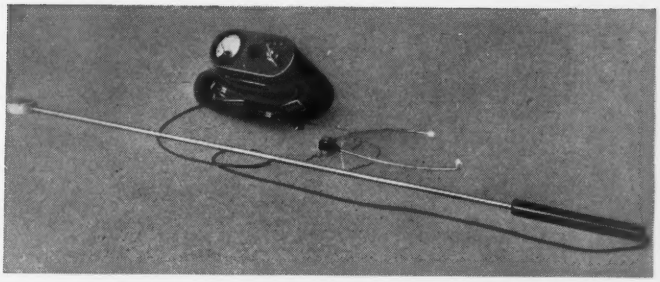
Water-cooled high-current germanium diode



Resonant cavity wavemeter

Nucleonic thickness gauge

Motor-driven automatic voltage regulator



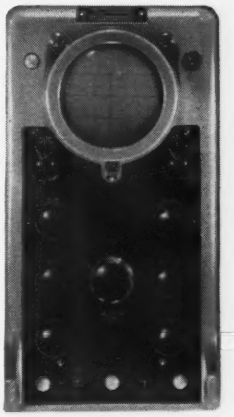
"Apidictor" beehive monitor

inductor, together with the current carrying conductor. The signal from the search coil, which is proportional to the rate of change is integrated by a c.r. network to give an e.m.f. proportional to current. In a nearby exhibit a fine jet of mercury, centrifugally expelled from an orifice rotating at 800 r.p.m. impinged successively on 60 stationary contacts, permitting sampling of small potentials of the order of a millivolt at the rate of 14 times per second each. The sensitivity of the moving coil galvanometer is used without the usual penalty of extended optical systems in a range of instruments in which a second rigidly attached coil lies in an alternating magnetic field. Rotation of the system of coils varies the flux linked with this second coil, and thus an alternating voltage proportional to the original deflecting current is obtained.

A radioactive source and counter registering either transmitted or back scattered radiation is typical of a class of instrument which will measure thickness very rapidly and without the need for any physical contact. A nucleonic thickness gauge on exhibition had a calibrated multi-turn potentiometer with a 100in scale length connected across a highly stable voltage source to provide a reference voltage. A meter can be scaled in units of thickness, weight, etc. Among the more improbable instruments exhibited was the "Apidictor," the prototype of which has been under extensive and successful field trials since it was exhibited two years ago. This instrument eavesdrops on colonies of bees, and by means of switched filters and a selective amplifier, the general health and the imminence of swarming can be detected, which is of considerable practical and economic importance.

Post deflection acceleration voltages up to 24 kV are being employed in cathode ray oscilloscopes, a large selection of which, together with accessory equipment was again on view. An instrument which falls more or less into this category is a millimicrosecond pulse generator and display unit. 100 V pulses of substantially "$\sin^2$" shape and of 5, 20 or 50 mμsec width are injected into, say, a cable and the echoes received from mis-matches are presented on a cathode ray tube display, the time base of which is derived from the same oscillator as provides the pulses. Alternatively, transmission or delay lines, or distributed amplifiers can be tested by examining the transmitted pulse at the far end of the network, where this is accessible.

An oscilloscope beam switch, two or more of which can be operated together, extends the usefulness of a single beam instrument to cover several channels. Input is through a cathode follower and the amplifiers, which have a frequency response from 10 c/s-10 Mc/s, are switched at a rate between 300 c/s and 3 kc/s. An oscilloscope camera has provision for single shot or continuous feed recording at speeds from 1 to 75in/sec; a.c. or d.c. motors of various speeds can be employed, driving the six-speed gearbox through a flexible shaft to reduce vibration effects.



Millisecond timer with eight ranges

Pulse generator and display unit for testing active and passive networks

Another exhibitor showed an end-of-film and footage indicator as an accessory to an existing camera.

A compact high voltage d.c. generator with an output of 0·75 mA at 350 kV and a smaller unit supplying 0·5 mA at 80 kV each consist of an oil immersed Cockcroft-Walton generator operating at a frequency of 65 kc/s. Output voltage is controlled by varying the oscillator power supply, and the upper half of the voltage range is stabilised. Power supplies at more usual voltages are available with very highly stabilised outputs: three examples were 0-500 mA d.c. at 300 V with a ripple plus noise content less than 0·3 mV, 0-3 kV high impedance output with ripple less than 20 mV, and 0-500 mA at 190-350 V d.c. continuously adjustable, stabilised to better than 6 mV and with less than 2 mV ripple. A d.c. stabiliser has an output continuously variable between a few volts and 1,500 V at a load of 0-150 mA. A five-dial decade resistor gives an accuracy of setting up to 1 in 10^5, and the output is stabilised against load and normal mains voltage and frequency variations. An automatic voltage regulator provides an output voltage from 195 to 260 V constant within ± 1 per cent, while input voltage varies within an 80 V range; maximum continuous current is 3·2 A. Control may be manual, from an external d.c. control voltage or internally rectified, and applied via thyratrons to a motor-driven auto-transformer.

Data Recording

A complete and highly flexible system of data recording and analysis employs magnetic tape recording, either direct or by frequency modulation, at 30in/sec on seven information channels, one of which may be reserved for speech editing, together with a reference channel for tape speed compensation on play-back. The recorder with power supplies is compact and comparatively cheap, and can be installed in vehicles or aircraft or in hazardous areas. A

calibrator for the frequency modulation channels and the play-back unit are crystal controlled, and the latter plays back at 30in/sec for speech editing only, and otherwise at 1in/sec. With a recording pen limited to 100 kc/s this enables the frequency modulation channels with frequency response up to 3,000 kc/s to be recorded. The analyser re-records 5 or 30 sec of original record and plots a frequency/amplitude spectrum on a potentiometer recorder.

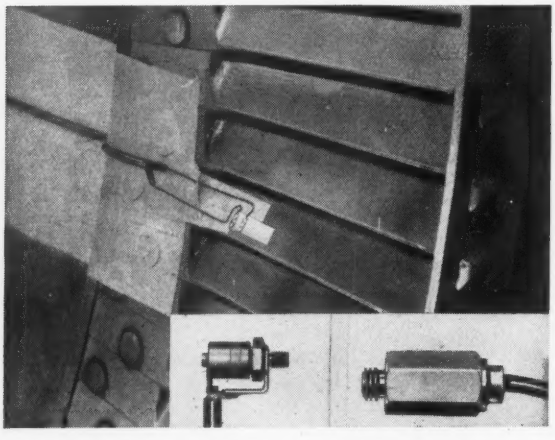
Finally, the exhibition featured two very interesting experimental developments in telephony. The first of these was, of course, an electronic automatic exchange, prompted by the similarities between digital computing and telephone switching. The model exchange exhibited has four lines, although the T.D.M. system employed has a capacity of 99 lines per switch. The pulse repetition frequency for each channel is 10 kc/s, and the duration of each pulse is 0·25 μsec; the subscribers' modulators and demodulators make use of point contact diodes in gating circuits and transistors in amplifier circuits. A register-marker, used to receive and store the digits dialled at 10 pulses per second by subscribers uses newly-developed cold-cathode tubes.

The other development was a noise-cancelling microphone. This is an electromagnetic type with a balanced magnetic circuit acting on a single diaphragm. Distant sources of background noise give rise to effectively equal sound pressures on both sides of the diaphragm, whilst the speaker's lips give rise to pressure differences and electrical output. This microphone was demonstrated built into a handset together with a three-stage transistor amplifier, as a direct replacement for a conventional handset for use in a noisy environment. The transistor power supplies are obtained along the same two wires as carry the speech currents.

Accelerometers and Strain Gauges

MINIATURE barium titanate accelerometers and strain gauges for use in vibration testing are new devices developed by the research laboratories of the General Electric Co., Ltd. Their very small size enables them to be used where it would be impossible to accommodate more bulky equipment.

The accelerometer consists of a circular disc of barium titanate about $\frac{1}{8}$in thick and $\frac{3}{8}$in in diameter, silvered on both sides and sandwiched between two pieces of brass, one of which forms the base and is terminated by a 2 BA stud for fixing purposes. The other acts as an inertia weight, converting the vibrations in the equipment to strains in the ceramic. The response of the instrument to accelerations of up to 1,000 g is linear. It gives a voltage output of about 20 mV/g and will detect and record frequencies in the range 20 c/s to 20 kc/s. A screened model is also available.



Strain gauge being used for vibration testing of a turbine blade and (inset) unscreened (left) and screened models of barium titanate accelerometers

The vibration strain gauge was originally developed for measurements of blade vibrations in rotating turbine wheels and is two or three thousand times as sensitive to alternating strain as a typical wire resistance strain gauge. It does not, however, respond to steady strain. The sensitivity is of the order of 0·1 V output for an alternating displacement of one part in 10^6 and, like the accelerometer, it will operate at temperatures between −50 deg and +100 deg C. If this range is departed from on either device the piezo-electric properties can be restored by repolarisation.

Atomic Power Progress

IN view of various announcements about the Calder Hall and Dounreay nuclear energy power stations which have appeared of late in the lay Press we asked the United Kingdom Atomic Energy Authority to let us know the present position in regard to the construction of these two stations. The following is the substance of the Authority's reply, dated 4th May.

The present position at Calder Hall is that work on the first of the two reactors is now very near the stage at which all contractors involved will have completed their part of the programme, and the Authority itself will take over to finish the loading of uranium and to start the tests which will be necessary before the reactor can operate fully as an electricity producer. The Queen will perform the opening ceremony at Calder on 17th October, at which time reactor No. 1 will be fully operational, and will be feeding electricity into the national grid through two 23 MW generators. Before this takes place the reactor will have to be allowed to become critical some time in advance, first at very low energy, which will be gradually built up as testing proceeds. Even the loading of uranium will be a fairly slow operation, since there will have to be very careful testing of the loading system. It is impossible to give an exact timetable of these processes, since much will depend on the progress of the testing. Reactor No. 2 will follow the same schedule, but exactly six months after reactor No. 1.

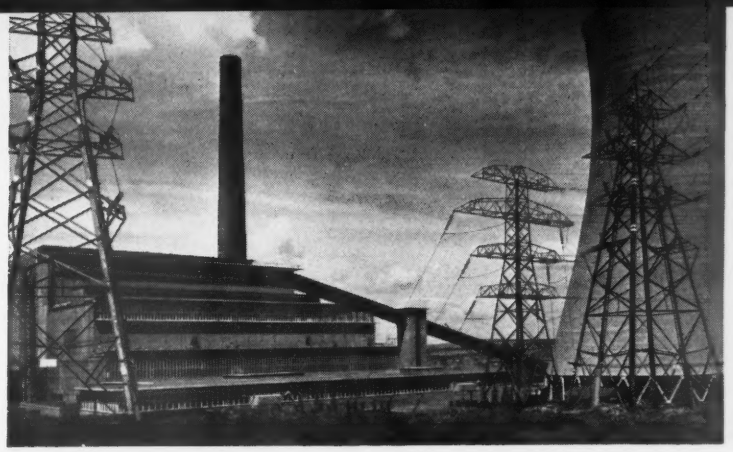
At Dounreay the bottom half of the 135ft diameter sphere which houses the reactor core shielding system and the biological shielding was completed early this year, and considerable progress has been made in constructing the biological shield and the structure on which the reactor and shielding will rest. The top half of the sphere will probably not be erected until some time next year, and the station is due to go into operation in 1959.

Electric Vehicles in 1955

THE report for 1955 presented at the recent annual meeting of the Electric Vehicle Association of Great Britain, Ltd., records that at the end of the year there were 27 full members and 13 associate members (including the B.E.A.M.A.). The total number of electric vehicles in use in Great Britain and Northern Ireland was 32,161 (against 30,823 in 1954); of these 21,690 were driver-seated and 10,471 pedestrian-controlled vehicles. New registrations in 1955 numbered 2,575. Of the 1,545 driver-seated vehicles included in this total the greatest number were in the 1-1½ ton range (506); next in order were the 12-16 cwt group (373), the 16-20 cwt group (368) and those not exceeding 12 cwt (245).

Particulars are given in the report of the Association's participation in exhibitions and conferences; of its publicity activities during the year; and of negotiations with Government Departments and other associations.

HUNCOAT POWER STATION



LOWEST COST GENERATION IN NORTH WEST DIVISION

ON 11th May the Huncoat power station of the Central Electricity Authority was formally opened by the Mayor of Accrington, Councillor W. T. Marriott, J.P. This station was planned by the Accrington Corporation before nationalisation for an ultimate capacity of 150 MW in 30 MW units, three of which have so far been completed. It is situated with its basement floor level at 526·00 O.D., making it one of the highest in the country. This fact had an unexpected benefit in that it gave a substantial improvement in the vacuum obtainable and enabled a higher efficiency to be achieved than was expected.

Coal is obtained for the most part direct from a nearby pit, by private railway, but about 20 per cent comes by road from another colliery a few miles away. These arrangements lead to the station having low fuel costs and the overall cost per kWh sent out, at about 0·406d, is the lowest in the North West, Merseyside and North Wales Division. Coal seams actually extend under the whole area and an agreement had to be concluded with the National Coal Board for the purchase of the pillar of coal under the station.

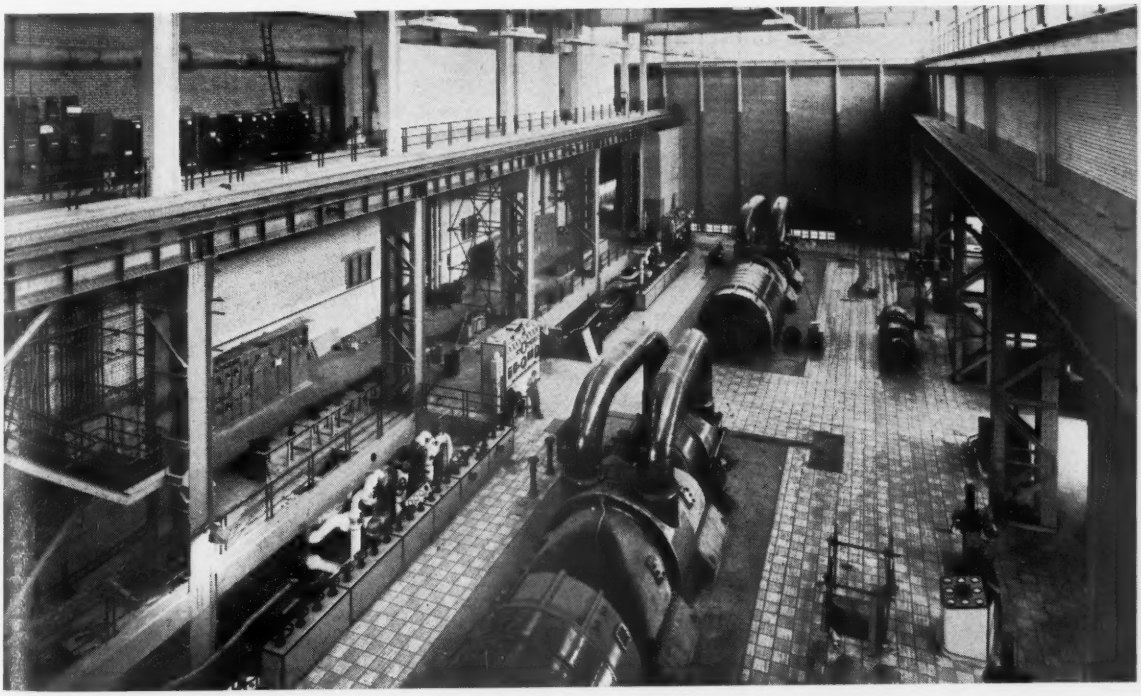
The thermal efficiency is of the order of 27·6 per cent. Although designed as a two-shift station, the low generating cost has meant more continuous running and in fact the load factor so far, over a year's running, has been 90 per cent. The machines came into operation in June, 1952, December, 1952, and September, 1955.

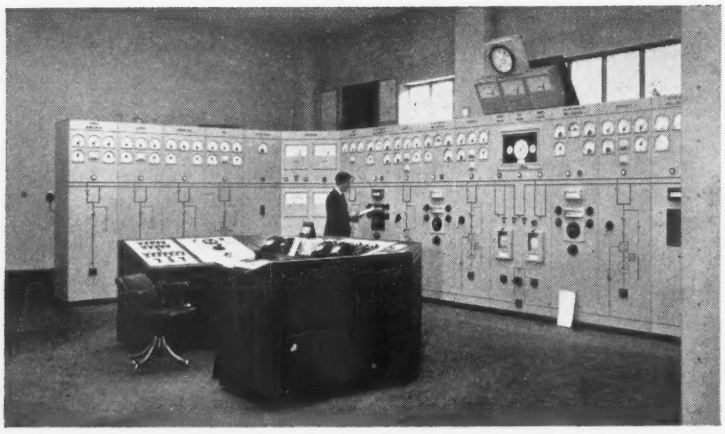
Two side-discharge wagon tipplers feed via conveyors to the storage area or to the boiler house bunkers. These are unusual in being of circular construction, about 30ft high, and having two access doors at intervals to facilitate trimming without the entry of people into the bunkers. Three Lopulco pulverising mills are installed per boiler and three burners are fitted at each corner of the boilers.

A 305,000 lb/hr Simon-Carves three-drum boiler is installed in conjunction with each of the generating sets. An electrically driven feed pump supplies the needs of each boiler, two spare electrically driven and two steam driven pumps being available for standby purposes on the whole range. Operating conditions of the boilers are 625 lb/sq in and 860 deg F.

Two forced draught fans each with a capacity of 49,000 cu ft/min and two induced draught fans each with a capacity of 80,400 cu ft/min are provided for each boiler,

The first two turbo-generators ; the station is planned for an ultimate capacity of 150 MW





Inside the control room

all these being driven by variable speed d.c. motors fed from rectifiers.

Ash discharges into a low-pressure sluice running the full length of the boiler house and runs to a large sump where the water is drawn off through reciprocating screens and pumped back to the head of the ash sluice. Two 100 per cent duty pumps of 25 h.p. are installed. Dust removal from precipitators, etc., is by a pneumatic system collecting to cyclones where it discharges into bunkers through mechanically operated air seals. Two 100 per cent duty pumps each driven by a 150 h.p. motor drive the exhausters. From the bunker the dust is discharged through a paddle wetting conveyor into ash lorries taking it to a valley adjacent to the power station. This has an estimated ash capacity for 25 years' operation.

The turbo-generators are by the General Electric Co., Ltd., the turbines being of the two-cylinder impulse type running at 3,000 r.p.m. Operating conditions are 600 lb/sq in and 850 deg F. Generation is at 11 kV. Steam is bled from the turbines at four stages to supply the l.p. feed heater and three h.p. feed heaters. Twin surface condensers are provided with a total surface of 30,000 sq ft per turbine.

Five cooling water pumps of the vertical spindle centrifugal type with a capacity of 24,000 gal/min each, will be installed at the station when complete. Two cooling towers of the natural draught type enable 3 million gal/hr of water to be cooled from 87 deg F to 70 deg F. The circulating system is constructed on a ring main on both the suction and discharge sides and both cooling towers can be run on a common system when five sets are operating or one tower can be used if the other is out of operation for maintenance, enabling 75 MW to be generated.

The generators connect to the 33 kV system through 40·5 MVA step-up transformers situated immediately outside the turbine house. These were provided by the General Electric Co. The main 33 kV switchgear by Reyrolle & Co. is of the oil-immersed metalclad type with a rating of 1,500 MVA.

The consulting engineers for the station were Messrs. Kennedy & Donkin, Messrs. Mouchel & Partners being responsible for the civil engineering work.

After Councillor Marriott had unveiled a commemorative plaque at the opening ceremony, a prayer of dedication was offered by the Bishop of Blackburn, and Mr. B. Donkin spoke on behalf of the consultants and contractors. Mr. P. Briggs, deputy divisional controller, made some concluding remarks.

Steam-Turbine Design

IN a contribution to the *Proceedings* of the Institution of Mechanical Engineers, Mr. Norman Elce (Metropolitan-Vickers) discusses the economic basis and character of modern steam-turbine design. He points out that since 1949, when K. Baumann considered the most economic pressure and temperature for a 3,000 r.p.m. condensing non-reheat unit of 50 MW, larger capacities at that speed have been designed, the capital costs of raising the temperature to 1,050 and 1,100 deg F have proved less than was formerly supposed, and thermal improvements due to reheating have been established. Moreover as the unit size increases the increase in capital costs per kW installed become less, resulting in a different economic pressure and temperature for every size of unit.

Variations of capital cost with steam conditions, capital value of fuel savings above 600 lb/sq in and 850 deg F for both reheat and non-reheat turbines are discussed, together with problems relating to the transient bending of rotor shafts in service and the design of diaphragms of impulse machines. For any practicable initial and reheat temperatures the capital cost ratio, reheat to non-reheat, appear not to exceed unity for 30 MW and to fall with increases in rating and in pressure. The general effect of the foregoing considerations are set out in the accompanying table.

Maximum continuous rating, MW	30	30	60	60	100	120	200
Cylinders	2	1	3	2	2	3 (reheat)	3 (reheat)
Stop-valve pressure, lb/sq in, gauge	600	900	900	900	1,500	1,500	2,350
Stop-valve temperature, deg F	850	900	900	900	1,050	1,000	1,050
Reheat temperature, deg F	—	—	—	—	—	1,000	1,000
Vacuum, inches of mercury	29·0	29·0	28·9	28·9	28·9	28·9	28·9
Number of feed heaters	4	5	5	5	6	6	7
Final feed-water temperature, deg F	330	380	385	385	400	436	475
Improvement in heat consumption relative to 30-MW 2-cylinder design, per cent	0	2·3	6·0	7·0	13·5	16·8	20·1
Relative weight per MW	1·0	0·67	0·74	0·70	0·52	0·52	0·46
Relative length per MW (turbine only)	1·0	0·58	0·74	0·53	0·36	0·40	0·27
Turbine and generator: Relative engine-room plan area per MW (including feed-water heaters, etc.)	1·0	0·59	0·76	0·68	0·47	0·44	0·31

Study of Combustion

THE USE OF TELEVISION EQUIPMENT

THE observation of furnace conditions is comparatively simple in the case of narrow stoker-fired boilers, but it has tended to become increasingly difficult as the size of boilers has increased. It has never been easy to get a good view of a large furnace through a comparatively small inspection door, and a blue glass and a stainless steel mirror have been the combustion engineer's constant companions for many years.

Boilers have now become so tall that combustion chambers can no longer be inspected from one or even two levels and, at the present time, a complete tour of inspection might take half an hour and involve climbing and descending more than 100ft of galleries and ladders. For about thirty years a standard fitting on many Babcock boilers has been a plain mirror periscope mounted outside the boiler, allowing the operator to view the upper zone of the combustion chamber from firing floor level, but this has its limitations, particularly with the present trend towards centralised control, which is often remote from the boilers. In addition, the universal use of pulverised fuel firing makes it more important than ever to keep a close watch on combustion conditions.

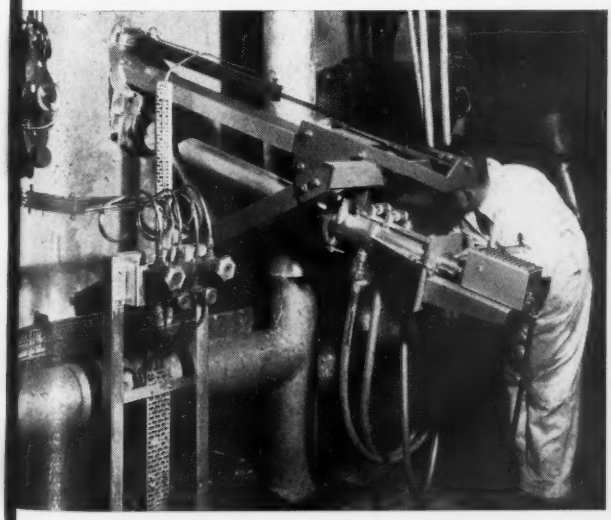
There is also the matter of the size of the inspection doors themselves. As is generally known, Babcock & Wilcox have introduced a system of pressure firing in which the furnace operates under forced draught, giving quite an appreciable pressure in the furnace instead of the slight suction normally obtained with the "balanced" draught operation employing f.d. and i.d. fans. Although improving thermal efficiency, this imposes limits on the size of inspection doors, which must themselves be arranged for opening under pressure, utilising an air blast "curtain" for protection, and are thus limited in area. While this is adequate for normal operation, detailed study of the combustion of different types of coal naturally requires special arrangements since the diameter is limited to 3 or 4in and the furnace wall, with tubes and insulation, may be as much as a foot thick.

The application of closed-circuit television to furnace observation has only recently begun to be seriously considered in this country. Although it is possible to obtain a picture of the interior of certain types of furnace by mounting a suitably protected camera directly on the furnace wall, this may, in certain cases, present problems which are difficult to resolve.

A new type of periscopic television equipment has recently been installed for furnace observation in Barking "C" generating station and last week we had the pleasure of seeing it in operation. One important feature of the arrangement is that the lens system used incorporates "entrance pupils" of the minimum possible diameter which are recessed so that the apertures can be kept free from fly ash. The overall design of the unit is such that it produces a comprehensive view of the interior, which, in some furnaces, could only otherwise be obtained by the use of at least two cameras operating from different viewpoints.

The equipment has been developed by Babcock & Wilcox, Ltd., in conjunction with the British Iron and Steel Research Association, Marconi's Wireless Telegraph Co., Ltd., and the Foster Instrument Co., Ltd., all of whom have given invaluable assistance in the perfecting of the various units making up the system.

The periscope, which is completely water-cooled, with



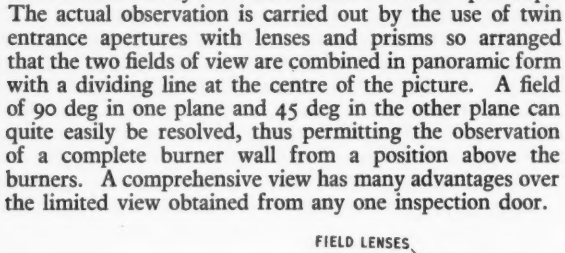
Above: Furnace television equipment with the periscope unit about to enter furnace

Right: Furnace periscope in service showing portable cooling unit with water tank, pump and blower

incorporated air-blast to keep fly ash from settling on the lens windows, is mounted, together with its associated television camera, on a carriage which can be advanced into the furnace or retracted by means of a "Martonair" remote-controlled air cylinder. If applied to a pressure-operated furnace, the nose of the periscope water jacket is fitted with a conical fairing to avoid interference with the flow of air in the air-blast door through which the unit enters. This takes the form of a circular opening with gas-tight flaps that are pushed open by the nose of the periscope as it advances. At the same time, high-pressure air is automatically admitted to a ring of nozzles which converge on the opening surrounding the doors. The velocity of these air jets is sufficient to induce air into the furnace and form a "curtain" which prevents any tendency towards the emission of gas or flame.

Optical System

The fundamental requirements of the optical system were, as have already been stated, a wide angle of vision without exposed lens surfaces. A periscope for furnace observation which answers some of these requirements was used some years ago (1949) by the British Coal Utilisation Research Association. Working from this, Mr. C. Burns, of the British Iron and Steel Association, developed a panoramic periscope which has an optical system as shown in the accompanying diagram. Although the main objective lens is of conventional design, it can be placed some distance away from the furnace end of the periscope. The actual observation is carried out by the use of twin entrance apertures with lenses and prisms so arranged that the two fields of view are combined in panoramic form with a dividing line at the centre of the picture. A field of 90 deg in one plane and 45 deg in the other plane can quite easily be resolved, thus permitting the observation of a complete burner wall from a position above the burners. A comprehensive view has many advantages over the limited view obtained from any one inspection door.



Optical system of panoramic periscope

The television apparatus is of the industrial type as developed by Marconi's Wireless Telegraph Co., Ltd. The camera is noteworthy for its small dimensions, since it employs a miniature "Vidicon" pick-up tube which measures only one inch in diameter. Associated with the camera are the usual control unit and power pack and one or more viewing tubes or monitors.

The scheme as installed utilises the normal complement of safety interlocks to safeguard against failure of cooling water or blast air and to ensure that both are available before the unit is advanced into the furnace. In addition, what might be termed "economy" controls have been fitted. There is very little need for continuous observation of a normal furnace when operating under stable conditions. The need for maximum visibility is during lighting-up, and in emergencies. The boiler control panel is fitted with a "turn-down" control so that the pick-up tube normally operates at considerably less than maximum brightness. A photo-electric cell is permanently arranged at another specially chosen point in the furnace to keep continuous watch and should the furnace brightness be reduced below normal, an alarm is sounded on the control panel. At the same time the periscope is automatically advanced into the furnace and a picture obtained on a T.V. screen. The operator would answer the audible alarm and, at the same time, immediately turn the camera output up to the maximum. The photocell could be arranged to do this automatically but, since the object of the alarm is to ensure that the operator immediately goes to the monitor screen to observe conditions, there seems little point in this additional refinement.

As already indicated it is possible to use this type of periscope for direct viewing and a portable unit is now being marketed by the Foster Instrument Co., Ltd., under the trade name "Babcock-Foster Furnace Periscope." This consists of the periscope unit, without a television system, and in this case it will be noted that the unit is suitable for either straight-line or right-angle viewing, according to which of the screwed plugs is removed from the barrel.

It might be considered that the necessity for both water and air cooling supplies would be an insuperable obstacle to portability but such is not the case. The cooling unit which can (without water) be carried by one man, consists of a water tank (a 5 gallon oil drum is very convenient) together with a small electrically operated circulating pump and an electric blower mounted as a unit with skids and carrying handles. The amount of water carried by this means will, it is stated, allow up to 20 minutes' observation and it is only necessary to allow the water to cool (or to change the water when convenient) to obtain another period of observation.

Australian News

From a Correspondent

THE Electricity Commission of New South Wales has issued a warning that the different coloured wiring of some European electrical goods can be extremely dangerous to amateurs making repairs. The earth wire, coloured green in Australia, is sometimes red in European appliances, particularly in hair clippers, movie projectors, photographic enlargers and infra-red equipment.

During the past month sales of domestic refrigerators have risen considerably, mainly because of the many "no deposit" agreements offered by sections of the trade, with low monthly payments and high trade-in allowances.

Twelve companies preparing to manufacture television sets for the Australian market have already allocated more than £3 million for plant and equipment. Each of these companies is linked either financially or technically with overseas producers of TV equipment—six with U.S. firms, three with British manufacturers, two with makers in both the U.K. and the U.S., and one with its parent company in Holland.

Mr. H. G. Schofield, president of the Electrical Manufacturers' Association of Australia, says that the future of Australia's electrical industry seems particularly bright. He adds, however: "A word of warning should be sounded on Australia's continually increasing cost structure. Our lavish scale of holidays, particularly the outdated trade picnic days, are indulgences which could be curtailed without imposing a strain on the workers." He quoted the following price increases from the end of the war in 1945 to 1954: Great Britain 54 per cent, New Zealand 56 per cent, Canada 56 per cent, U.S.A. 48 per cent and Australia no less than 106 per cent. These figures, he said, illustrated the necessity of getting costs down.

Fluorescent Lamp Manufacture

Automatic Production of Atlas 8ft Fluorescent Tubes

DURING the post-war years Thorn Electrical Industries, Ltd., has played a leading part in the development of fluorescent lighting for industry and commerce. The demand for quantity and quality has been tremendous and this has only been met successfully by constant improvement in development and production techniques.

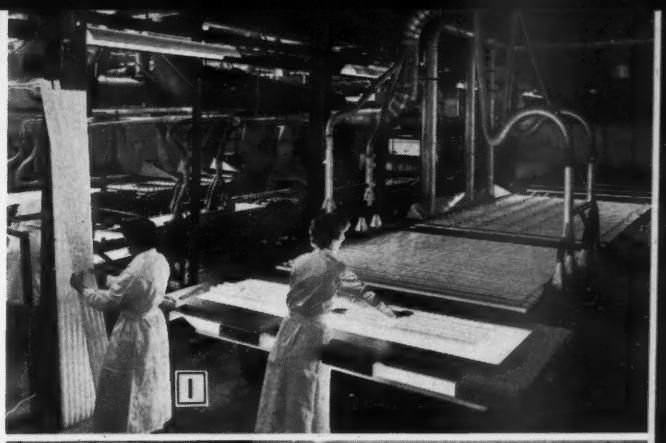
Until recently the manufacture of "Atlas" fluorescent tubes and fittings has been concentrated on the standard 2ft, 3ft, 4ft and 5ft tubes. The demand for continuous lines of lighting and larger illumination areas has established the need for a longer tube, which is being made in the 8ft length. Until recently only small quantities of the 8ft tube were made, but new automatic plant, the first in this country, has now been installed by the company for the large-scale manufacture of these tubes.

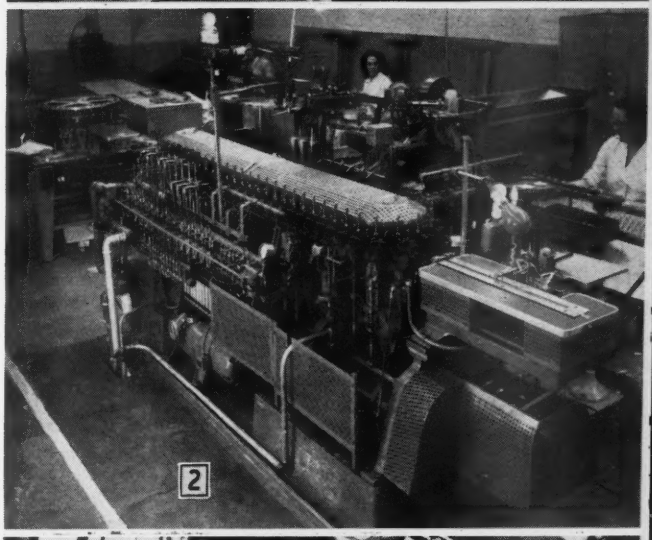
Last week we had the opportunity of seeing something of the company's resources in the laboratory, in powder production, in machine building, in component manufacture and assembly planning, which are all most necessary for automatic production in large quantities.

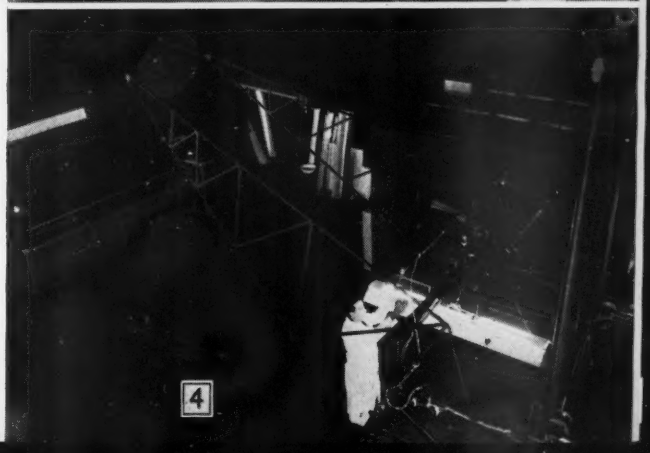
The high quality of "Atlas" tubes has been made possible not only by the background of knowledge and experience available in the company on all aspects of manufacture, but also by the Machine Building Department of Thorn Electrical, where much of the complicated machinery necessary was constructed.

The bulk manufacture of fluorescent materials is an important activity at the Enfield factory. Although the amount used in each lamp is small, the company claims that it produces over half the country's fluorescent tubes and total requirements are measured in tons. To meet the additional demands made by the 8ft tube a new furnace room has been designed where an impressive range of furnaces bake the fluorescent powder under carefully controlled conditions.

Upon arrival at the factory the glass tubes have first to be washed. With the introduction of 8ft tubes, modifications had to be made; a larger washing tunnel has been installed and thousands of gallons of pure water are used in this process every hour. After drying, the tubes are conveyed automatically to the coating room where they







1. *The coated tubes are dried and passed through a baker and then down a long conveyor for end-cleaning and inspection*

2. *The stem assembly which seals the ends of the lamps and carries the filaments or cathodes is manufactured on this high speed automatic unit*

3. *From the sealing machine the tubes are carried by conveyor to the finishing unit consisting of a group of machines; first the automatic pump, then the capping machine and finally the ager*

4. *This photometer can measure the light output from a lighting fitting in any direction and is an essential instrument in determining performance*

are flooded from the top with jets of fluorescent material in fluid suspension. Sixty-three tubes are dealt with at one time by this coating method.

From the coating room the tubes pass through a baker and down a long conveyor for end-cleaning and inspection. The new roller-baker and conveyor, capable of handling several thousand 8ft tubes every day, is one of the largest and most impressive-looking assemblies in the factory and was designed and built by the Machine Building Department.

On the sealing machine the stem assemblies are sealed in at both ends of the tube. This stem assembly, which also carries the tube cathodes, is manufactured on a high-speed automatic unit which is one of the most up-to-date of its kind and with one other similar machine manufactures the bulk of the requirements for the entire factory. From the sealing machine the tubes are carried by conveyor to a finishing unit consisting of an automatic pump, capping machine and ager. A massive group of machines has just been installed for the 8ft tubes and to facilitate handling, a raised gallery has been constructed on which the operators stand.

An important section of the Enfield factory is, of course, the lighting laboratories, upon which responsibility for the design and quality of the product ultimately falls. Intensive research is continually being carried out on fluorescent materials and colour control, and it is here that the control gear for the 8ft tube was designed. One of the most interesting items of equipment in these laboratories is the large photometer used to measure the light output from various types of fittings under normal operating conditions.

Another important aspect of the work of this department is the temperature testing carried out on all ranges of equipment. Although fluorescent lamps run at very low temperatures, control gear in the enclosed fittings can reach heats at which its life is affected and stringent preliminary tests are made on all designs before they pass into production.

Tubes selected from each of the production units throughout the day are tested in this department for light output and life tested for varying periods up to many thousands of hours. Approximately 70 kW is used on life test in this section alone.

The ballast section is concerned with the electrical control equipment, such as chokes, transformers and capacitors, necessary for operating all fluorescent and vapour discharge lamps. Close contact is maintained with other sections of the laboratory during design and development since it is essential to ensure that lamps and control gear function together satisfactorily.

Many of the items in the new 8ft lamp manufacturing group have been built at Enfield, and the Machine Building Department has its own section for jig-boring, optical angular division and high precision gear cutting, all conducted in a temperature controlled enclosure. There is also a cam-milling section which in addition to producing all the cams required for the Thorn organisation has been employed on making high precision cams for other major industrial organisations.

This excellent view of the interior of Keadby power station is being shown by Mr. Gordon W. Banks, A.I.B.P. (Central Electricity Authority) at the National Exhibition of Professional Photography, R.B.A. Gallery, Suffolk Street, London, S.W.1 (16th May–9th June)

Rhodesian Electricity Act

FROM A SALISBURY CORRESPONDENT

THE new Electricity Act of the Federation of Rhodesia and Nyasaland came into force on 1st May, and the Federal Power Board and Electricity Supply Commission of Southern Rhodesia began operations under the Act on this date. The Act also applies to Northern Rhodesia although no Supply Commission has yet been formed. No part of the Act applies to Nyasaland although it has been reported that a Supply Commission may be formed in this territory on 1st July to take over the functions of the present Department of Electrical Services.

The Federal Power Board has been directed under Government Notice No. 115 "to establish the undertaking for the supply of electricity from the waters of the Zambesi River at Kariba Gorge." The chairman and members of the Board are the same as those of the Federal Hydro-Electric Board which it supersedes. The chairman and members of the Electricity Supply Commission of Southern Rhodesia are the same as the old Commission which has been functioning since 1936.

Numerous regulations have also been published including those for the acquisition of land; interconnection appeals; general regulations for Northern Rhodesia, which include regulations for the wiring of premises; annual returns; registration of private undertakings; private undertakings' contracts; non-standard tariffs; licensing; Electricity Authorities (Membership and Proceedings); and the Electricity (Southern Rhodesia) Regulations.

In the Electricity Authorities (Membership and Proceedings) Regulation provision is made for two copies of all minutes to be sent to the Minister of Power, relating to meetings of the Federal Power Board, Supply Commissions and Electricity Councils. This is a new requirement.

The Annual Returns called for have now to relate to a calendar year and as this does not always coincide with the financial year it appears that some extra paper work will be necessary for supply authorities.

The Northern Rhodesia Regulations are a simple and straightforward statement of requirements which suppliers must fulfil, and British Standards are cited. Similarly for the wiring of premises, the I.E.E. Wiring Regulations (13th edition) are quoted.

In Southern Rhodesia, up to the present, the requirements of the South African Bureau of Standards and the South African Institution of Electrical Engineers have often been used in place of the standards now specified, and it will be of interest to see whether these same standards will be quoted when new regulations for Southern Rhodesia are promulgated.

One of the first duties of the Electricity Council for Southern Rhodesia will be to advise the Minister of Power on the recent application by the Electricity Supply Commission of Southern Rhodesia for a 15 per cent surcharge on all electricity accounts to balance income and expenditure. There has been considerable opposition to this from the Chamber of Mines.

Mine Locomotives

IN a paper to the Utilisation Section of the Institution of Electrical Engineers on 15th May, Mr. T. E. Green said that during the last 15 years over 800 battery and diesel locomotives of about 40 different designs had been put to work in British coal mines, 600 of them since the formation of the National Coal Board in 1947. There was no type or design which was outstandingly superior and consequently the search for some alternative form of motive power, or, in wider terms, for some more efficient method of transporting coal, men and materials underground, went forward incessantly.

There could be few fields of traction service where locomotive design was more restricted than in mining. The size of the mine road and the provision of the statutory clearances compressed the cross-sectional area in a high degree. Road conditions limited the maximum weight to about 15 tons and a great deal of running in the mine was done at 8 m.p.h. or less. The length of a locomotive was capable of some variation, but if excessive, it might prove difficult to lower the unit down the shaft. Some of the newer designs provided for the locomotive frame to be divided into two parts, or alternatively, for the driving cabs to be removed for transport down the shaft. Most of the locomotives were simple two-axle designs, but three of the heaviest diesel locomotives were carried on three axles and this enabled the load per axle to be kept down to 5 tons.

The general locomotive regulations were drafted to enable battery and diesel locomotives to be used on an extensive scale with a minimum of formality. Other types of locomotive were subject to additional restrictions, so that if they were to be introduced or their use was to be extended, considerable additional difficulties had to be negotiated. The installation of trolley or pantograph locomotives was subject to special regulations being established, but one such set did now exist and might be taken as a good guide for other cases.

Battery locomotives ranged in size from 2 tons, 5 h.p. to 13 tons, 90 h.p. The same general design obtained throughout, with some additional equipment and facilities in the larger sizes. All were carried on two axles, and except for the larger sizes, they had a single driving cab at one end.

The pleading of motor designers over the years for the adoption of wider track gauges was being met by an increasing proportion of haulage schemes using 3ft; the cost of driving roads of sufficient size for these wide tracks was high. The motors were invariably provided with a simple 4-pole field system, and wave-wound roller-bearing armatures. A carbon brush fitted with a Neoprene pad, intended for use under conditions of severe mechanical shock, had recently been developed and some brushes of this type were now undergoing trials in a Scottish mine.

Controllers, resistors and other equipment developed

for surface work were enclosed in flameproof boxes, and restricted to the simplest types of circuits, proved a useful addition to mining equipment. As might be expected the resistors were one of the most difficult items; the interaction of flameproof enclosure and rating combined with the severe space restriction and the absence of any reliable operating data presented the designers with a particularly awkward problem.

The economics of underground battery locomotives turned very largely on battery performance and cost. A marked improvement in either of these two factors would strengthen the claims of the battery units, and much consideration was being given to this problem.

The lead-acid and alkaline types of batteries were both practicable if the latter was restricted to the nickel-iron and nickel-cadmium varieties. More recent developments offered no immediate attraction because of high cost and short life. Actually, only the lead-acid type was in use underground; regulations were being drafted to establish safe conditions for nickel-iron cells.

Since battery dimensions were so severely limited the time/capacity characteristic was of critical importance. Curves showed the heavy reduction in available capacity with increase in the rate of discharge, and since many mine roads followed an undulating path, heavy current discharges could form an excessive drain.

Further E.T.U. Conference Decisions

FULL inspection of all new electrical installations so as to lessen the number of accidents, particularly domestic, was called for in a resolution sponsored by the Birmingham Power Supply Branch at last week's policy conference of the Electrical Trades Union at Hastings.

Moving the resolution, Mr. A. J. Walsh said that in the Birmingham Sub-Area there was a 10 per cent inspection of jobs. "In view of what inspectors find in the 10 per cent one shudders to think of what is missed in the remaining 90 per cent," he said.

Mr. L. W. Goodwin (London) declared, "We have got to go forward for stricter control of the additions to installations which cause most of the accidents in the home and the factory."

Mr. H. J. Howie (London) said there had been a "wave" of accidents because of "amateur" workmanship in electrical installations in shops, factories and homes, and Mr. D. Sheasby (Manchester) remarked that in one factory there were "whole sections of the installations that would not pass a Girl Guide inspection."

The resolution was carried unanimously.

On the other hand a motion calling for a register of all electrical operatives and employers in the interests of public safety and an amendment adding the stipulation that electrical operatives should be issued with a State authorisation card were both defeated. Mr. L. J. Gregory, for the Executive Council, said that one reason for registration in other countries was the amount of wood in buildings. The National Inspection Council was the only basis upon which common agreement had been reached.

A rather subdued debate on electronics brought out little that was new. The initiation of training and apprenticeship schemes was approved, and members were asked to assist at factory level in establishing such schemes. Endorsement was given to the institution of "an extensive recruiting campaign in the electronics section of the industry, in view of the growing importance of automation in industry." A demand for a national wage structure in electronics was formally approved.

A composite motion to bring Schedule "E" (Foremen) of the N.J.I.C. National Agreement into line with the salaried staff as regards statutory holidays and time off from work was carried, as was a further motion that foremen in charge of craft grades should be included in Grade 1. The conference again supported the request that the Executive Council should press for overhead linesmen to be paid the skilled rate.

One resolution on the agenda urged that electricians should not drive their firms' vehicles unless it was a recognised part of the job. The Lift and Crane Branch, however, favoured the alternative course of asking the Executive Council to get, where possible, an increased rate in such cases and this had the backing of the conference.

On questions of a more general nature the delegates approved a resolution which expressed grave concern over the small differential at present existing between the tradesman, the chargehand and the foreman. Another, opposing wage restraint, was supported by Mr. R. G. MacLennan on behalf of the Executive. He said that the Union repudiated the idea that wage increases inevitably led to higher prices. The resolution was carried.

The electrical contracting industry came in for attention on Thursday morning. A composite motion claimed that time rates in the industry placed electricians at a disadvantage as compared with electricians in industries where there were plus earnings, and the Executive was requested to press for a substantial increase in wages to make good the difference.

"Excessive Overtime" Complaint

The conference later adopted a resolution expressing "deep concern" at the continued excessive overtime being worked and calling for a drive to bring about the speedy reduction of overtime hours.

Mr. E. Hammond, of Gravesend, said that overtime was tied up with redundancy. They must get back to the idea that it was nothing short of immoral to work overtime while others were out of work.

Mr. E. J. Murphy, of Sidcup (Kent), moved a resolution calling for an all-out effort to establish the five-day forty-hour week without loss of pay in all sectors of the industry, including Government Departments. Mr. N. B. Christie, of Dundee, referred to the growing practice of compulsory overtime and said there was increasing evidence of fatigue coupled with more industrial accidents. In view of the coming of automation the campaign for a 40-hour five-day week was essential.

A Putney Branch motion requesting the union's executive "to bring pressure to bear on the T.U.C. to urge the Government to grant legal status and powers to a Monopolies Commission with strong T.U.C. representation incorporated" was also adopted.

COFFEE PERCOLATORS

The next in our series of illustrated surveys of domestic electrical equipment (1st June) will deal with coffee percolators. Particulars to be given in tabular form will include details of the type, capacity, loading, body finish, price, purchase tax, etc. In view of the continued demand for these surveys for reference purposes, orders for additional copies of the *Electrical Review* should be placed without delay. On 22nd June electric toasters will be dealt with.

ELECTRONIC TELEPHONY

Development of the Switched-Highways System

ALL telephone systems incorporate time-sharing techniques in order to economise in apparatus, but the extent of their application depends upon the operating speeds and adaptability of the components used. The introduction of electronic techniques enables various switching, coding and sampling techniques to be used to achieve a higher degree of time sharing than has previously been possible.

In a paper presented at a meeting of the Radio and Telecommunications Section of the Institution of Electrical Engineers on 9th May Mr. L. R. F. Harris, M.A. (Post Office Engineering Department) said that these principles were the main basis of design in a system now under development. Connections were made over common leads using pulse channels each of which might be used for connections to any line. The connections were controlled by register and supervisory apparatus in which information was received, stored, manipulated and transmitted by common apparatus which operated on the connection pulse channels. Common selecting, translating and marking apparatus was used to set up all connections on a one-at-a-time basis, and all apparatus apart from the line-terminal equipment was time-shared by the connections using either sampling or switching techniques. Connection, register and supervisory apparatus was also time-shared by coding. The capital and maintenance costs of such a system were as yet indeterminate, but it was expected that they would be competitive.

Sufficient information had been derived to show that the traffic-carrying capacity of the switched-highways system would be adequate. This capacity was improved if various preferred selecting arrangements were used, when the traffic per group might approach the traffic offered to a full-availability group for a given grade of service. More accurate traffic data were hardly required at the present stage of development.

DISCUSSION

In opening the discussion, Mr. G. C. Hartley (Standard Telephones) said that in the traditional switching field the country had not been so well explored as it should have been. The suggestion that current developments were merely the extension of old principles was misleading, for many of the ideas were basically new and required a fundamentally different approach.

Mr. D. A. Barron (Post Office) observed that the system that was ultimately successful would be a compromise between first cost on the one hand and complexity and maintenance difficulty on the other. One feature of the electronic system was speed, and one of the most important potential aspects of the switched-highways system from this point of view was trunk exchange switching. It should permit of a fast setting-up time, coupled with a suitable signalling system for fast inter-register connection.

Dr. J. H. Mitchell (Ericsson) thought the system proposed was a considerable advance on the only one previously presented. It showed a marked advantage in pulse economy, although a more flexible and elaborate pulse generating and pulse storage unit was required. He did not think time sharing should be taken too far, as it placed a high premium on reliability.

Mr. T. H. Flowers (Post Office) expressed the view that the switched-highways system showed to maximum advantage in large exchanges, because the conventional crossbar exchange required so much more switching and wiring. For the smallest type of exchange, units were envisaged having a simpler time sharing or type of multiplex which was a two-wire both-way gate. With the two types of units it was expected to cover exchanges of all sizes with various configurations in a very economical manner.

Mr. N. C. Smart (G.E.C.) considered that an entirely satisfactory and most attractive automatic exchange system had been described in the paper. Time sharing by sampling and coding was the next logical step in the development of such exchanges and it would rank with some of the other historic "firsts," such as the development of the step-by-step selector. However, this was a research project and development, engineering and manufacture were likely to be difficult. Nevertheless, he felt sure the industry could face up to the difficulties.

Maintenance Requirements

Col. C. E. Calveley (Post Office) mentioned the enormous effort that would be required of the maintenance men with the switched-highways system and the corresponding training problem.

Mr. E. P. G. Wright (Standard Telephones) thought there could be no serious dispute that time sharing as a basis for electronic telephone switching had come and must enter into the picture. He felt that more should have been said about maintenance, because the design of an electronic system must be based on maintenance, and the reliability of components was one of the first considerations.

Mr. L. J. Murray (Automatic Telephone & Electric Co.) said that the determining factor in the design of a time-division multiplex system was the limitation, by the present sampling techniques, of the number of pulse channels in one highway to 80 or 100. The switched-highways system overcame the difficulty by dividing the exchange into groups and switching them by a multiplicity of inter-group gates. In view of the number of inter-group gates, it seemed likely that costs would rise.

Mr. J. E. Flood (Siemens) expressed the view that there would inevitably be difficulties in transmission associated with transmitting time-division multiplex with a large number of channels over substantial lengths of cable. He had no doubt that Dollis Hill could do it with 80 channels, but it would probably be expensive in that complicated subsequent equalisation or alternatively predistortion of the pulses before transmission would have to be used.

Mr. Baylis (G.E.C.) said that three developments had occurred which had made this type of telephone exchange possible. The first was the efficient use of the multiplex channels so that all channels could be used efficiently at the busiest time of the day. The second was the provision of an economical source of pulses for operating the gates in subscribers' line circuits. The third was the use of the switched-highways system itself, involving only one modulation and one demodulation process. He showed a slide of a model telephone exchange built by his company on these three principles and emphasised the saving in space which could be achieved by the use of electronic switching techniques.

Mr. P. W. Ward (G.E.C.) said storage could be quite efficient and the memory item was not particularly expensive. The cost did not go up alarmingly with a large exchange, as there were so many different connections between groups and to some extent coding could be used. He asked whether any problems had been experienced with cross-talk.

Mr. R. Syski (Hivac) said that for exact calculation of the lines in an exchange the interdependence of stages and groups should be taken into account. This meant considering the whole exchange as a unit.

NEW ELECTRICAL EQUIPMENT

Domestic Immersion Heater

An all-purpose domestic immersion heater which is capable of housing any one of three distinct types of thermostat, the Satchwell "V," the Satchwell "VC" and the "Otter," has been produced by the GENERAL ELECTRIC Co., LTD., Magnet House, Kingsway, W.C.2. The heater, which has a 2¼in BSPT head, is available with a loading of either 2 or 3 kW and the price for all lengths from 11in to 30in is £2 10s plus £1 2s purchase tax in the United Kingdom.

The Satchwell "V" thermostat is a 20 A a.c. rod type made in 11 and 18in lengths with a visible temperature adjustment and calibrated dial providing a temperature range from 70-190 deg F. The prices are £1 10s (11in) and £1 12s (18in).

The Satchwell "VC" thermostat is a 15 A a.c. adjustable rod thermostat made in 7, 11 and 18in lengths providing the same standard of control over a temperature range of 120-180 deg F as the "V" type, but with the temperature setting device at the end of the stem. Respective prices are 17s 6d (7in), 18s 6d (11in) and 19s 6d (18in).

The "Otter" thermostat, which does not have a stem but fits in the head of the heater, is a fixed temperature setting thermostat made with 140, 160 and 180 deg F settings and rated at 20 A a.c. The price is 15s 3d.

A full range of 2¼in BSPT fixing accessories is available for the heater, including bolt-on flanges, sweating flanges and locknuts, and circulator tubes.

Switch Clips

A range of fuse and switch clips has now been built up by the SYNTHETIC CARBON & ENGINEERING CO., LTD., Cumberland Road, Stanmore, Middlesex, who have developed a tooling technique ensuring that the clip as sent out, can be used without the necessity for grinding in or specially setting. The current ratings available at present are 15, 30, 60, 75, 100, 150, 200 and 300 A and alternative types can be made to customers' specifications. All clips are made from high conductivity hard drawn copper and can be supplied with terminal studs and nuts to suit.

Dry Shaver Adaptor

One of the latest additions to a range of multi-plug adaptors and accessories manufactured by LOBLITE, LTD., Third Avenue, Team Valley Trading Estate, Gateshead-on-Tyne, 11, is the "Razor-Daptor." It is designed to fit a 13 A socket and overcomes the difficulty experienced in using a dry shaver on a ring-main circuit. Two outlets in the head of the plug take either round or flat pin shaver plugs. Each is fused at 1 A to protect the shaver. The price of the adaptor (list No. 135) is 4s 6d (brown) or 5s (grey or white).

Small Diesel Generators

STAR ENGINES, LTD., Friars' Road, Coventry, recently sent us their new publication describing the 3½ kVA "Pegasus" and "F" model generators. The power unit of these is a single cylinder vertical four-stroke medium speed solid injection diesel with a rating of 5·5 h.p. at 1,500 r.p.m. A high inertia flywheel is fitted and cooling is by a thermosiphon aided by a fan. The sets are available for hand starting, local push-button starting or remote control.

High Quality Loudspeaker

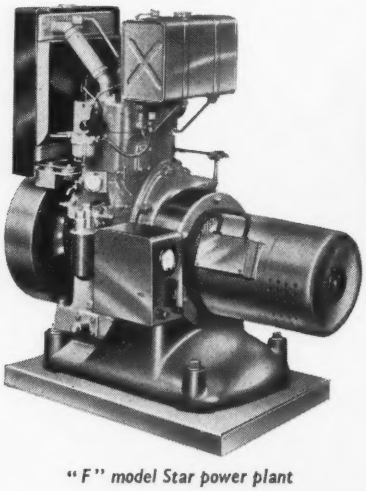
A new design of loudspeaker for high quality sound reproduction has been brought out by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby. The unit, type K10A, is a coaxial dual-channel speaker having an 18in diameter l.f. cone assembly with a twin mouthed h.f. horn mounted in the centre pole and coupled by a special form of phase-equaliser to an anodised aluminium alloy diaphragm. To divide the high and low audio frequency energy from the amplifier an external filter unit having a cross-over frequency of 1,700 c/s is used.

Electric Cookers

A new automatic electric cooker, the "Falco-Freedom," is announced by FALCO ELECTRICAL APPLIANCES, LTD., Corporation Road, Audenshaw, Manchester. It is of pressed steel construction with cast-iron hob, and measures 36in high to hob by 22in wide and 19½in deep. Two boiling plates (6¼ and 8in) and a grill/boiler provide ample facilities for hotplate cooking. The 8in plate is fitted with "Simmerstat" control. The oven is of three-piece construction, easily removed for cleaning and interior measurements are 13 by 13 by 14½in.

All the controls are streamlined self-indicating switches; 3-heat, 4-heat and "Simmerstat" controls can be fitted as required. There is a large hot-cupboard and grill compartment, and a utensil drawer is also provided. The finish is in cream or white vitreous enamel with cream, white or black hob, and the loadings are: oven, 2,400 W; grill/boiler, 2 kW; 8in plate, 1,800 W; and 6¼in plate, 1 kW. The price is £51 15s.

The company also announces that

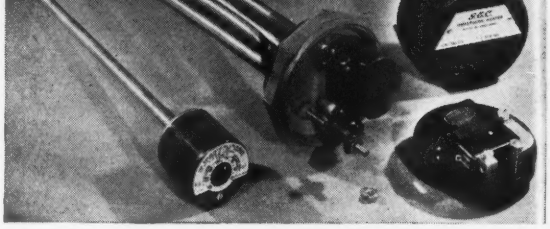


"F" model Star power plant

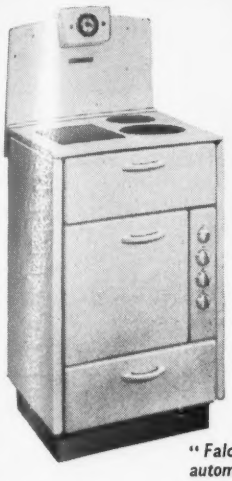
Rear view of the B.T.H. loudspeaker showing the tandem permanent magnet assembly

Loblite "Razor-Daptor"

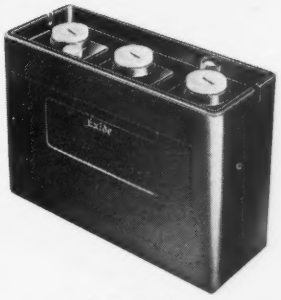
"Syncarbon" clip



Right: G.E.C. domestic immersion heater with the three types of thermostat that can be housed within it



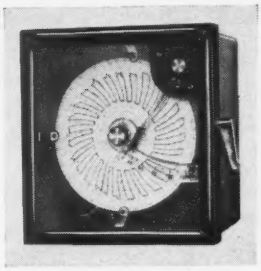
"Falco-Freedom" E.C.20 automatic electric cooker



Exide 3-DU3 battery

Right: Hotpoint HB heated washing machine

Line recorder (Kandem Electrical)



the "Falco Royal" cooker has been reduced in price to £76 13s and that in addition to the existing cream or white finish, the cooker will now be available in pastel shades of blue, green or pink.

Washing Machine

The new model HB washing machine announced by the HOTPOINT ELECTRIC APPLIANCE CO., LTD., Crown House, Aldwych, London, W.C.2, has been designed for the smaller kitchen but retains the essential advantages of the more expensive models.

The water is heated by a 1½ kW chromium plated "Torribar" immersion heater fitted with safety cut-out and positioned beneath the gyrator in the recessed bottom of the bowl. The water capacity is 8½ gal and the machine will take 5 lb of dry clothes. There are push-button controls for motor and heater with distinctively coloured on and off buttons. An automatic emptying pump is also fitted and the wringer, which is hand operated, folds away neatly when not in use.

The cabinet is 29in high by 17½in wide by 18in deep and is finished in gleaming white stoved enamel with grey plinth. Two voltage ranges are available, 200/220 or 230/250 a.c. only. The price is £40 12s plus £16 7s 5d purchase tax in the United Kingdom.

Silver Rivet Contact

JOHNSON, MATTHEY & CO., LTD., 73-83, Hatton Garden, London, E.C.1, have introduced a new type of silver rivet contact. This is a composite contact made up of a silver facing on a copper backing, and novel manufacturing methods enable it to be produced at a lower cost, size for size, than the larger types of solid silver rivets.

A feature of the new contacts is the tubular shank which simplifies the riveting operation, and the use of copper for the backing ensures that the electrical and thermal conductances of the rivet are for practical purposes as high as if it were made entirely of silver. Tubular contacts have the same current rating as solid contacts of the same dimensions.

The range of sizes available includes two main types, one with a flat contact face and the other with a domed contact face and in each of these types four head sizes from ⅛in to ¼in diameter are available.

Gas Turbine Generator

DALE ELECTRIC (YORKSHIRE), LTD., Filey, now have in production a new gas turbine portable generating plant having a total weight of 1,232 lb, compared with a diesel engine powered plant of similar output which has a weight of about 8,000 lb. The sets have an output of 50 kVA at speeds of 3,000 or 3,600 r.p.m. corresponding to 50 or 60 c/s. The dimensions of the unit are 6ft by 3ft 1in by 3ft. The power unit is flange mounted to the alternator through a reduction gear box and a centrifugal clutch and a switchboard is fitted on anti-vibration mountings on the top of the alternator and is complete with meters, control valves, etc. The plant is normally arranged for hand starting but electric starting can be incorporated if required. The whole assembly is mounted in a tubular cradle of steel tube with a built-in fuel tank.

Electric Fence Battery

A new "Exide" fence battery, built to withstand the rigours of all-weather operation and hard usage, has just been introduced by CHLORIDE BATTERIES, LTD., Clifton Junction, Swinton, Manchester. It is the 3-DU3, a 6 V unit which is claimed to have long life, reliability, low cost and economical operation. The plates are of the mass type, and the separators are made of Porvic. Diatomite electrolyte absorber fills the entire acid space and makes the battery completely unspillable. The unit has a tough one-piece moulded container and large filling orifices to simplify routine maintenance.

With a capacity of 20 Ah at the 100-hour rate of discharge, the 3-DU3 weighs 15 lb fully charged and is designed to provide the small current required by electric fences for long periods.

Chart Recorder

A new circular chart recorder, type RB192, has been developed by Hartmann & Braun to meet the need for an inexpensive line recorder for the continuous recording of mains voltage or current. It is being marketed by KANDEM ELECTRICAL, LTD., 711, Fulham Road, London, S.W.6. The recorder is only 7½in square and is fitted with a bimetal movement. By means of a magnetic a.c. field arranged around the pen small 50 c/s vibrations are produced so that the movement of the pen is practically frictionless. Alteration of the gears enables the recorder to be provided with a chart duration of 28 hours, 7 days or 28 days. The price of the recording ammeter is £28 16s and of the recording voltmeter £32 8s.

Small Fluorescent Tubes

A new 6 W 9in fluorescent tube is announced by PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2. In addition to its many applications in the domestic field for various forms of decorative lighting, for bedheads, cabinets and other furniture, and for installation in cookers and similar household apparatus, it is also suitable for showcase and display lighting in the shop-fitting trade. Its applications in the industrial field include hand-lamps, inspection lamps, etc. The tube employs the same circuit as standard fluorescent tubes, using a small, open-type choke and a starter switch. It is available at present only in the "cool white de-luxe" colour and the price is 11s 6d plus 2s 5d purchase tax in the United Kingdom. The choke retails at 17s 8d, and the starter switch costs 3s 3d.

The new tube is one of a range of three: 4 W 6in and 8 W 12in tubes, selling at 15s, plus 3s 2d purchase tax, are also available in limited quantities.

PARLIAMENTARY REPORT

IN the House of Commons Mr. Harold Macmillan, Chancellor of the Exchequer, gave a list of the fuel-saving plant which he proposed should qualify for the investment allowance when the Finance Bill became law. It included certain types of mechanical firing equipment for solid fuel, oil firing equipment, back pressure engines and turbines (including generators, switchgear, etc.), waste heat recovery equipment, feed-water treatment plant and control equipment.

Development Work by Research Associations

In reply to Mr. Callaghan, the Parliamentary Secretary to the Ministry of Works (Mr. Bevins) said that development work was an important part of the work of research Associations which the Government encouraged by means of grants paid by the Department of Scientific and Industrial Research. These grants supplemented the contributions made by industry. The resources devoted to development were decided by the Councils of the associations which were made up predominantly of industrialists but included representatives of the Department. The associations as a whole spent approximately a quarter of their budgets or over £1 million on development.

Mr. Callaghan asked for much more development to be done through the research associations for the benefit of industry generally.

Mr. Bevins said the Government knew of the recommendation by the Advisory Council on Scientific Policy, and several development companies had been formed by research associations. In addition, the Government was trying out the method of giving civil development contracts to scientific research associations.

Effects of Automation

Answering a question by Mr. Osborne, the Minister of Labour (Mr. Iain Macleod) said it was not possible to forecast the rate at which automation would be introduced or the number of workers whose employment might be affected. The Government would take steps to make factual information about automation known generally. It was for individual firms which were contemplating its introduction to consider how it would affect their workers and to bring them into early discussion.

Sale of Surplus Equipment

Mr. Norman Dodds asked the Secretary of State for War why 1,400 dry batteries and 3,000 dry cells were disposed of at a Government surplus auction sale at Bicester on 8th May.

Mr. Fitzroy Maclean said the batteries and cells, which were taken into stock in 1952, had become unserviceable and were not, therefore, offered to other Departments. Their cost was £752. The last orders placed for such items were for 23,000 dry batteries and 60,000 dry cells during 1955-56. Other things auctioned at Bicester included 8,900 rolls of insulating tape which were purchased in the last war and had become unserviceable, and 19,800 electric lamps, similar to battery-operated bicycle lamps, which were surplus to foreseeable requirements. No lamps of this type had been bought since 1943 and no further orders would be placed. The lamps could have been withdrawn from the sale if other Government Departments had asked for them.

Consents to Overhead Lines

Mr. Vane asked the Minister of Fuel and Power whether he was aware of the long delays in deciding the routes of overhead electricity lines in national parks owing to the large number of interests concerned and the inevitable difficulty of reaching agreement, and whether he would introduce a simpler procedure.

Mr. Renton said that only in rare and exceptional cases affecting certain national park areas had prolonged consultations been found necessary. These had been due to the difficult issues involved and the Minister did not consider that it would be feasible to introduce a simpler procedure.

Pressed further, Mr. Renton said that if there should be a vast number of delays—which so far there had not been—the Minister would no doubt need to consider further action.

Compensation for Power Failure

Mr. Geoffrey Stevens asked the Minister of Fuel and Power what provision he had made for compensation for damage caused by irregular and inefficient supply of electricity by an Electricity Board in his regulations made under Section 60 (1) of the Electricity Act, 1947.

Mr. David Renton, Parliamentary Secretary, replied that compensation was a matter to be settled in the courts and the 1947 Act gave the Minister no power to make regulations on the subject.

Mr. Stevens said circumstances did arise when, on reconnection after a cessation of power due to failure at a power station, there was a surge which could damage television sets and other electrical equipment. Did the Minister not feel that the owners of such damaged equipment were entitled to compensation from the Central Electricity Authority?

Mr. Renton said that there could be all kinds of unfortunate consequences of power cuts and technical faults. If anybody wished to claim compensation, that was a matter for the courts to decide and not one which could be decided in advance by making complicated regulations.

Trade with Russia and China

Replying to several questions, Mr. Antony Nutting, Minister of State, Foreign Office, said that the list of goods and materials under embargo for export to the Soviet bloc was under continuous review. About two-thirds of the goods which the Russians said they wanted to buy were free of restriction and the Board of Trade was already in touch with the Soviet trade office in London concerning the possibilities.

Mr. Swingler asked for a statement concerning the Foreign Secretary's recent talks with the American Secretary of State on strategic controls on trade with China.

Mr. Nutting stated that the discussions were not yet concluded. In the meantime, however, more use would be made of the exceptions procedure to permit reasonable exports in appropriate cases to China of goods which were not on the Soviet lists.

Dame Irene Ward asked the Government to bear in mind that if they delayed too long British industry might lose the Chinese market altogether.

Mr. Nutting said he realised this but we must proceed in consultation with our friends and allies.

Pensions in Scotland

Mr. Palmer asked the Secretary of State for Scotland if he would approve, for ex-company pensioners of the electricity supply industry in Scotland, pension increases similar to those now approved for England and Wales.

Mr. J. Stuart said he had informed the Scottish Electricity Boards that he was prepared to approve the payment of increases in the pensions of ex-company pensioners for whom these Boards were responsible. The details of the increases to be paid were at present under consideration.

Fuel Research Station

Mr. Arthur Skeffington asked the Minister of Works by what date it was proposed to provide at Stevenage the new accommodation planned for the Fuel Research Station of the Department of Scientific and Industrial Research.

Mr. Buchan-Hepburn said building work should start in 1957 and that the first part should be completed about three years later. No date had been fixed for starting the second part of the project.

GENERATION AND DEVELOPMENT

C.E.A. Contracts

Contracts have been placed by the Central Electricity Authority during the past month for power stations, transforming stations and transmission lines amounting in the aggregate to £3,165,240. The principal contracts include the following:—

Barking "C" power station: Conversion of five 405,000 lb/hr pulverised fuel boilers to oil firing.—Babcock & Wilcox.

Marchwood power station, near Southampton: Two feed heating and condensing plants.—Vickers-Armstrongs (Engineers).

Little Barford "B" power station, near St. Neots: Two reinforced concrete cooling towers.—Yorkshire Hennibique Contracting Co.

Ironbridge power station, Shropshire: Uprating 132 kV switchgear.—General Electric Co.

Blyth "A" power station: Coal handling plant.—Birtley Co.

Holborn (Back Hill) substation: Site and foundation.—London Electricity Board (to be carried out by Higgs & Hill).

Slough substation: Two 30 MVA, 132/33 kV transformers.—Johnson & Phillips.

Ryeford substation: Two 60 MVA, 132/33 kV transformers.—British Thomson-Houston Co.

West Melton substation: Two 120 MVA, 132/275 kV auto transformers.—British Thomson-Houston Co.

Hams Hall power station to Coventry substation: 132 kV overhead line.—British Insulated Callender's Cables.

Increased Output in April

Last month 6,952 million kWh was generated by the Central Electricity Authority, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board. This was 850 million kWh (13·9 per cent) more than in the corresponding month of 1955 and raised the average rate of increase for the first four months of the year to 10·2 per cent, as shown in the accompanying table.

At the end of April the total capacity of plant installed was 22,705 MW compared with 22,615 MW in the previous month, an increase of 90 MW.

Plant installed in C.E.A. stations last month included 60 MW Metropolitan-Vickers sets at Portishead "B" and Carrington, and an 830,000 lb/hr Babcock & Wilcox boiler at Castle Donington.

River Lee Hydro-Electric Scheme

The River Lee hydro-electric development, the fourth of its kind to be undertaken by the Electricity Supply Board, Dublin, is now nearing completion. The dams and power stations at Inniscarra and Carrigadrohid are well advanced and delivery of the mechanical and electrical plant will shortly begin. Both stations are expected to be in operation next year. The gradual damming up of the river and the flooding of the Lee Valley into long narrow lakes covering 3,500 acres is expected to commence, in the case of the upper lake, in August next and the lower lake in September.

Deferment of North Wales Schemes Criticised

At a recent meeting of the Merseyside and North Wales Electricity Consultative Council at Llandudno the chairman (Mr. H. Evans) said he had received representations from building trade organisations protesting against the Central Electricity Authority's decision to postpone the Ffestiniog and Rheidol schemes.

Mr. A. R. Cooper (divisional controller, North West, Merseyside and North Wales) in a letter to Mr. Evans stated that the C.E.A. had decided to defer schemes in an early stage so as to minimise as far as possible restrictions on new plant which was to be brought into commission in the next two years. "You may rest assured," added Mr. Cooper, "that work on both these developments will be resumed as early as national considerations will allow."

The meeting was told that many industrialists were avoiding North Wales on account of the uncertainty regarding electrical development in the area. It was decided to ask the divisional controller to attend a meeting of the Consultative Council to discuss the matter.

On the question of rural electrification, the chairman said he had received a letter from Ogwen R.D.C. protesting against recent Government measures curtailing this work and citing instances of people having wiring installed and now having to face a long wait before being connected.

The chairman said it was not quite correct to say the Government had enforced measures against rural electrification. People had assumed the programme would be held up. The Boards were now considering what the effects would be of the 10 per cent cut in capital expenditure. Rural electrification had in fact been running ahead of the five-year programme and would probably now revert to the original schedule.

Treatment of Wood Poles

In its recent annual report the Uganda Electricity Board referred to the treatment of wood poles to prevent rot and attack by termites and other insects. Mention was made of the failure of poles impregnated by the hot-cold bath process, not under pressure, with a water soluble preservative. Since 1952 the Board has been using creosote exclusively, applied under vacuum and pressure, and so far this has been satisfactory. Nevertheless, tests are being continued with other preservatives and the Board has now arranged to have a small number of poles impregnated, also under vacuum and pressure, with another preservative of the waterborne type. These poles will be installed for comparable testing under Uganda conditions.

Canadian North-West Project

Northwest Power Industries, Ltd., has announced its proposal to go ahead with plans for a power development project on the Yukon-British Columbia border and is starting field surveys in the Whitehorse area shortly. Last December the company informed the Gordon Commission on Canada's Future Economic Prospects that "international complications" had forced it to shelve its 4,900,000 h.p. development plans. At that time, it said it would switch emphasis to the 450,000 h.p. Nass River project, which would be strictly within the Canadian borders.

Electric Water Heating

The Housing Committee of Lambeth Borough Council proposes that water heaters provided in its houses shall be electric.

ELECTRICITY GENERATED AND PLANT INSTALLED

	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total		
Central Electricity Authority ...	3,320	72	33·1	6,401	3	6,411	6,010	20,764
North of Scotland H.E.B. ...	23	—	1·2	37	77	119	117	723
South of Scotland E.B.	217	6	—	416	6	422	399	1,218
Total for April, 1956	3,560	78	34·3	6,854	86	*6,952	6,526	22,705
Corres. total for April, 1955 ...	3,123	105	17·7	5,997	93	6,102	5,730	20,836
Inc. or dec. per cent.	+14·0	−25·3	+93·8	+14·3	−7·0	+13·9	+13·9	+9·0
Total to date (4 months) 1956 ...	16,611	350	139·2	31,540	547	32,156	30,253	
Total for corres. 4 months of 1955	15,284	452	92·1	28,595	527	29,184	27,482	
Inc. or dec., per cent.	+8·7	−22·5	+51·0	+10·3	+3·9	+10·2	+10·1	

* The total figure includes generation by other methods amounting to 12 million kWh.

Financial Section

STOCKS and SHARES

BY Whitsun the industrial markets of the Stock Exchange reckon that the main season of dividend declarations and company results for the preceding year is nearing the finish. In this year's reports from most of the big electrical and other manufacturing enterprises, the heavy capital expenditure of former years upon plant and equipment is seen to have produced a further and considerable expansion of turnover. Improvements in net profits have seldom been commensurate. The effect of successive wage increases upon the costs of production has combined with high taxation and the credit squeeze to making it increasingly difficult for the progressive firm to hold prices down and, at the same time, to finance development out of its retained earnings. Dividend decisions have consequently leaned well towards the conservative side. On the whole, however, this year's crop of results is reviewed with reasonable satisfaction.

Company News

Richardsons Westgarth's final dividend goes to capital increased by the "rights" issue of shares last autumn, and makes a total of 10d per share (16⅔ per cent), the same as before; this outcome was forecast at the time of the issue, which had as part of its purpose the financing of facilities to manufacture the much larger plants now in demand. Last year's report mentioned steps taken towards placing the group in a position for participation in atomic developments. Profits in the latest period, ended in March, are about 10 per cent up, and cover the dividend on the single class of ordinary capital two and a half times over. The return on the shares at 16s 3d is a fraction over 5 per cent. In the annual report of Chloride Electrical Storage, stockholders are advised that if expansion continues at the recent rate the company may have to seek further funds. The £1 "A" shares have been firm at 63s 3d, yielding 5½ per cent on the 17½ per cent dividend.

Ever-Ready Prospects

Ever Ready 5s ordinary units (which, incidentally, are said in the company's report to be distributed among more than 13,000 stockholders) were well maintained at around 28s 9d after the appearance of the chairman's statement with the full accounts. He has another year of successful progress under review, and is able to report a satisfactory start to the present trading year, beginning last March. Restrictions imposed by the Government in that month are said to have affected temporarily the demand for the "All dry" receivers, but matters have subsequently improved and there is reason to expect the maintenance of good trading in both home and overseas markets. More factory accommodation is being acquired, and the demands which this and other items of capital expenditure are making upon the company's resources are evidently a factor in the decision to keep the ordinary dividend at the previous rate of 35 per cent. This comes from earnings equivalent to almost 100 per cent on the nominal capital, and produces a yield of over 6 per cent on the 5s shares.

Rheostatic New Shares

Rheostatic are doubling the issued ordinary capital by a one-for-one offer of new 4s shares at par to existing shareholders. The new shares have been quoted at a premium of 4s 9d to 5s, and become fully-paid to-day, Friday. On the former capital the company paid 18½ per cent for 1954-55 and expect, given a continuance of present trading conditions, to be able to recommend a total distribution of not less than 12 per cent on the £739,200 ordinary capital now ranking. This indicates a yield of 5⅓ per cent on the new shares at a total cost of 9s (free of transfer stamp). The new capital is needed for factory extensions, now largely completed, and for financing the continued growth of turnover.

Recent Results

An improvement to 8s in the price of Telephone Manufacturing 5s shares witnesses satisfaction with the company's decision to maintain, on capital increased by a one-for-five scrip issue, the 10 per cent rate of dividend paid for a number of previous years. The increase in the net profit (after increased taxation) from £133,000 to £146,000 again leaves a comfortable margin between earnings and the amount of the dividend distribution. The yield on the shares now becomes 6¼ per cent. British Thermostat 5s shares were dealt in at about 28s 9d after the declaration of the final dividend and preliminary figures. Dividend policy of the company remains strictly conservative, the total dividend of 25 per cent being covered some four and a half times over by the higher net surplus. It compares with last year's payments of a 20 per cent dividend with a special 7½ per cent bonus, and brings the yield on the shares to 4·3 per cent.

T.I. Dividends

Tube Investments £1 shares have come in for renewed support since the declaration of a 6¼ per cent interim dividend on account of the year ending next July. The price has recently been around 66s. This payment compares with the rate of 5¾ per cent indicated by the company at the time of the big capital issue last autumn. The intention then was to follow it with a final of 7 per cent. It was explained that, making allowance for the period during which the new capital remained partly paid, the total rate would be the equivalent of 14 per cent per annum, and it is on this dividend basis that the shares have subsequently been assessed. With the interim increased above the estimate, the market is now inclined to raise its sights a little, so far as the prospective total is concerned.

Cable & Wireless

Cable & Wireless (Holding) ordinary shares, previously in £1 form, have been quoted in 5s units for the last month or so. The split came as part of the proposals outlined by Sir Edward Wilshaw, at the annual meeting, for encouraging the small investor to invest his savings in industry through the medium of the investment trust company, with its great spread of interests over all fields of commerce. Cable & Wireless is shown in the latest balance-sheet to hold quoted investments worth close on £20 million at the end of last year, as well as other large assets. In the chairman's view, the position is strong enough to assure maintenance of the present 10 per cent rate of dividend for as far ahead as can reasonably be foreseen; and the intention is to distribute it in equal quarterly payments. Any excess of earnings would enable the board to pass on advantages in other ways. A first quarterly dividend of 1½d per 5s share has already been declared, together with a report of higher earnings in the first three months of this year. The yield on the shares at 11s 3d is 4·4 per cent.

Preference Shares

High-grade preference shares are mostly quoted these days at a level of prices which shows the buyer a yield some 1 per cent above the return on War Loan, currently about 4¾ per cent. Among preference issues recently on offer in reasonably large numbers, those offering 5¾ per cent, or thereabouts, on the money include G.E.C. 7½ per cents at 25s 9d, the 8 per cent shares of Crompton Parkinson at 28s and Pye 5½ per cents at 19s 3d. Of the higher yielders, Anglo-Portuguese Telephone "sixes" and Berry's Electric 6½ per cent could be bought at around par.

FOUNDRY WORK SCHOLARSHIP

On the recommendation of its Training Committee and with the support of the Joint Iron Council Finance Committee, the Council of Ironfoundry Associations has informed the Birmingham University authorities of the intention to establish in the autumn a research scholarship in a branch of foundry work in the Department of Industrial Metallurgy. The J.I.C. has agreed to make a grant of £300 per annum for four years.

REPORTS and DIVIDENDS

Johnson & Phillips, Ltd.—The annual meeting was held on 17th May, Mr. G. Leslie Wates (chairman) presiding. In his address to shareholders, Mr. Wates referred to the provision of further permanent capital by the issue of unsecured loan stock, reference to which was made in our last issue.

Dealing with the manufacturing activities outside the Charlton and New Cross factories, he said that the Scottish factory at Newarthill was primarily concerned with the manufacture of domestic appliances, the market for which had been affected by the Government restrictions on capital outlay by Area Boards on distribution schemes, and the credit squeeze. They were, however, manufacturing other products at the factory and thus keeping redundancy to the minimum.

The overseas branches had made a good contribution to their trading balance. Much attention had been given to the factories in Australia, South Africa and Pakistan, and they had recently established a section at Charlton especially to deal with the problems of these factories and to improve liaison between them and the Charlton works. Of the total output from Charlton, over 40 per cent was exported and about 30 per cent went to nationalised industries and Government Departments. After criticising the distributed profits tax, Mr. Wates referred to his resignation from the office of joint managing director, leaving Mr. W. Glass as managing director of the company. As we have already announced, Mr. Wates will continue to serve the company as chairman.

The Ever Ready Co. (Great Britain), Ltd.—The annual meeting will be held on 6th June. In his circulated statement, Mr. E. N. Rowbotham (chairman) says that substantial progress was achieved in most divisions during 1955 and the year was the best in the company's history both as regards sales and earnings. The demand for their products at home was well maintained. Export business substantially exceeded estimates and the Berec Export Division, having expanded its representation, achieved sales which were 20 per cent greater than last year's record. Owing to the labour shortages at the largest factories they were unable to meet all the demands for their products in some markets. A new factory is to be built in the Midlands and one has been acquired in the Eastern Counties. Subsidiary companies on the Continent have again had a satisfactory year.

Enfield Rolling Mills, Ltd.—The annual meeting was held on 16th May. In his circulated report the Earl of Verulam (chairman) said that 1955 was another record year. In May last one of their main suppliers of copper, the Rhodesian Selection Trust Group, offered fixed prices to those customers who were willing to instil a degree of stability into the re-sale prices of copper and brass products. Enfield Rolling Mills had accepted this offer and for nearly three months the price of copper they had contracted to buy from the Group remained stable on a basis of £280 per ton. Since then there had been only three alterations to the price, which had kept both stable and very close to the level at which the bulk of the world production was sold. They had passed on the whole of the reduction in price to their customers, and he had no doubt this had helped to prevent the substitution of copper by other metals in their customers' works and had also helped to make products more competitive in export markets. Turnover had been well maintained for the first two months of 1956, but thereafter the slowing down in some sections of the motor trade, and amongst makers of domestic appliances, had been reflected in the order book.

Simon-Carves, Ltd.—The preliminary statement for 1955 shows a consolidated profit of £1,386,477, as compared with £942,160 for 1954, and after deducting taxation of £614,578, minority interests of £3,571 and undistributed profits carried forward in the account of the subsidiary company of £107,441, there is a net balance of £660,787 (against £447,850). It is proposed to pay a final dividend on capital of £1,000,000 of 17½ per cent, which with an interim dividend of 11¼ per cent paid on £525,000 capital, makes 28¾ per cent for the year. For 1954, an interim dividend of 10 per cent was paid on £477,235, and an interim and a final dividend, both of 10 per cent, on capital of £524,958. Reserves receive £367,500, and the balance carried forward is £600,170 (against £441,469 brought in).

Subject to Treasury consent, the directors propose that the authorised capital of the company should be increased to £2,000,000 by the creation of 2,000,000 ordinary shares of 5s each and these are to be issued as fully paid to shareholders in the proportion of one new share for every two shares held. They will rank *pari passu* with the existing ordinary shares except that they will not participate in the final dividend in respect of 1955. It is proposed to effect the capitalisation out of the share premium account.

Richardsons, Westgarth & Co., Ltd., report that subject to final audit, the net profits for the year ended 31st March last are £495,000, as compared with £446,000 for 1954-55. Taxation absorbs £575,000. It is proposed to pay a final ordinary dividend of 10 per cent, making 16⅔ per cent for the year. The final dividend is paid on capital increased from £1,769,360 to £2,185,732 by a rights issue last September. The interim dividend of 6⅔ per cent and the previous year's single payment of 16⅔ per cent were paid on the smaller capital.

The Chloride Electrical Storage Co., Ltd.—The annual meeting will be held on 6th June. In his review of the past year's activities, Mr. A. W. Browne (chairman and managing director), says that the level of sales has been well maintained in practically all markets and shows an increase over the previous year. Costs have continued to rise, but their policy has been to absorb these increases wherever possible. Since the end of the year further increases have had to be met and it is becoming increasingly difficult to hold prices at the present level. Reviewing the battery business, Mr. Browne says that "Silver-Exide," "Chloride" and "Dagenite" batteries for vehicles continue to find favour with the public both at home and overseas. The new atomic power stations require large batteries, the first of which has already been installed. The improvement in export business, noted last year, has continued.

The British Thermostat Co., Ltd., reports that after providing £333,834 for taxation, the net profit for the year to 31st January last is £321,290, as compared with £293,793 for 1954-55. A sum of £183,774 is placed to general reserve and it is proposed to pay a final dividend of 17½ per cent, making 25 per cent for the year. For the previous year the total dividend was 20 per cent, and in addition a special bonus of 7½ per cent was paid. The balance carried forward is £464,772 (against £400,895 brought in).

The Calcutta Electric Supply Corporation, Ltd., proposes to pay an unchanged final dividend of 3 per cent, maintaining the ordinary distribution for 1955 at 6 per cent, tax free. The gross revenue for 1955 was £5,859,483, as compared with £5,291,657 for 1954. Expenditure totalled £4,334,257 (against £3,898,066), and taxation £418,000 (£95,000). After special appropriations of £317,223, placing £73,224 to contingency reserve fund and £35,000 to retiring gratuity fund, etc., the balance carried forward is £136,163 (against £152,818 brought in).

The Telephone Manufacturing Co., Ltd.—The group profit for 1955, after deducting £185,461 for taxation, is £146,228, as compared with £133,167 for 1954. The proposed final dividend is 7½ per cent, making 10 per cent for the year on capital increased by a one-for-five scrip issue. The dividend for 1954 on the old capital was 10 per cent.

Holophane, Ltd., has declared an interim dividend of 7½ per cent (same).

Associated Electrical Industries, Ltd., announces a quarterly interim dividend of 2½ per cent on the ordinary stock.

FINANCIAL SECTION (*continued*)

New Companies

Albert Morgan and Co., Ltd.—Registered 5th May. Capital £4,500. To acquire the business of an electrical and mechanical engineer and contractor carried on by A. Morgan at 50, Wilkin Street, N.W.5, as "Albert Morgan & Co." Directors: A. Morgan, J. A. Morgan, Adeline G. Morgan and S. A. Herbert. Solicitors: Judge & Priestley, 25, East Street, Bromley, Kent.

Provincial Aerials, Ltd.—Registered 12th April. Capital £1,000. Manufacturers, importers and exporters of and wholesale and retail dealers in electrical and mechanical appliances, radio, telephonic and telegraphic appliances, etc. Directors: L. J. Pickering and Margaret E. Newland. Regd. office: 103, Cannon Street, E.C.4.

Warnes (Swindon), Ltd.—Registered 1st May. Capital £5,000. To acquire the business of electricians, electrical engineers, contractors, dealers and engineers of and in radio and television sets and electrical appliances carried on by E. M. Crook and Hannah C. Crook at 160, County Road, Swindon, and 9, Swindon Street, Highworth, as "Warne Bros.", etc. Directors: E. M. Crook, Mrs. Hannah C. Crook, A. Robinson and W. S. House. Regd. office: 160, County Road, Swindon, Wilts.

C. P. Electrical, Ltd.—Registered 1st May. Capital £100. To manufacture, sell, install, let and fit any stands, apparatus or fittings for exhibition or show purposes; and to carry on the business of electrical contractors and engineers, electricians, etc. Directors: L. R. Courtney (director of Courtney, Pope, Ltd., etc.), C. R. Lyon (director of Courtney, Pope, Ltd., etc.), and A. H. Olson (director of Courtney Pope (Electrical), Ltd.). Regd. office: Amhurst Park Works, Seven Sisters Road, N.15.

R. Levitt, Ltd.—Registered 27th April. Capital £5,000. Electrical engineers and general electrical installation contractors, etc. Directors: R. Levitt, Marjorie Levitt and H. Craven. Regd. office: Low Street, Sherburn in Elmet.

Leslie Maynard, Ltd.—Registered 28th April. Capital £1,000. Electrical manufacturers' agents, manufacturers, electrical engineers, etc. Directors: L. Maynard and Doris G. Maynard. Solicitors: Stoneham & Sons, 108a, Cannon Street, E.C.4.

Henley Burrowes & Co., Ltd.—Registered 28th April. Capital £2,000. To acquire the business of electrical engineers and manufacturers of electrical equipment now carried on by A. C. Wynne and Cecilia M. E. Wynne, at Kings Norton, Birmingham, as Henley Burrowes & Co., etc. Directors: A. C. Wynne and Cecilia M. E. Wynne. Regd. office: 61, Birmingham Factory Centre, Kings Norton, Birmingham, 30.

Electrofuses, Ltd.—Registered 30th April. Capital £500. Manufacturers of and dealers in electronic equipment and electrical appliances of all kinds, radio and television sets and parts, fuses of all kinds, etc. Directors: B. Sternlicht, G. D. Perkins and A. Barnett. Regd. office: Triumph House, 189, Regent Street, W.1.

Chas. H. Young, Ltd.—Registered 24th April. Capital £4,000. To acquire the business of communications engineers and radio and television dealers carried on by C. H. Young and S. J. Phillips, at 110, Dale End, and 102, Holloway Head, Birmingham, etc. Directors. C. H. Young and S. J. Phillips. Regd. office: 110, Dale End, Birmingham, 4.

Cawdell's of Luton, Ltd.—Registered 25th April. Capital £6,000. To acquire the business of an electrical contractor carried on by H. A. W. Cawdell, at Luton, etc. Directors: H. A. W. Cawdell and Ena M. Cawdell. Regd. office: 55, Wellington Street, Luton.

Bankruptcies

W. C. Lawman, 27, Selbourne Road, Luton, electrician.—Receiving order made 8th May on debtor's own petition.

C. A. Smith, residing at 199, May Lane, Kings Heath, Birmingham, 14, and lately carrying on business at 4, Gothic Arcade, Snow Hill, Birmingham, under the style of Birmingham Electrical Co., electrical contractor.—Last day for receiving proofs for dividend 26th May. Trustee, Mr. R. K. Clark, Somerset House, 37, Temple Street, Birmingham, 2, Official Receiver.

A. W. Truman, carrying on business as Trumark Electrical, 24, Verulam Avenue, London, E.17, electrical engineer.—Receiving order made 10th May on a creditor's petition.

S. L. Blythe, G. N. Bryan and **D. Mosley,** formerly trading together in co-partnership under the style of Kirkstall Radio & Electrical Service, at Kirkstall Lodge, Edwinstowe, Notts, radio and electrical engineers.- First and final dividend of 4s 3½d in the £, payable on and after 30th May at York House, Alfred Street, Leeds.

B. J. Wheldon, 336, Londonderry Road, Langley, Oldbury, Worcs, electrician and radio salesman.—Supplemental dividend of 18s 3½d in the £ (making 20s in all) together with 4 per cent statutory interest, payable on and after 7th June at the Official Receiver's office, Somerset House, 37, Temple Street, Birmingham, 2.

CATALOGUES AND LISTS

CABLES.—Three folders covering the company's "Elpesthene" polythene insulated cables, thermoplastic cables and flexibles, and television downlead cables.—**L.P.S. Electrical Co., Ltd.,** 122, Drury Lane, London, W.C.2.

CLEANERS AND POLISHERS.—Illustrated catalogue (618) of domestic and industrial vacuum cleaners, floor polishers and floor scrubbers.—**Drake & Gorham Wholesale, Ltd.,** 77, Long Acre, London, W.C.2.

FLUORESCENT LIGHTING.—12-page booklet describing the company's special system of fluorescent lighting for ships.—**Philips Electrical, Ltd.,** Century House, Shaftesbury Avenue, London, W.C.2.

FURNACES. — Descriptive brochure (M8A) dealing with direct-arc melting furnaces.—**Metalectric Furnaces, Ltd.,** Smethwick.

GENERATING SETS.—Broadsheet illustrating and describing new mobile engine-driven power units.—**Dale Electric (Yorkshire), Ltd.,** Electricity Buildings, Filey, Yorkshire.

INSTRUMENTS.—Descriptive booklet dealing with the "Atomat" nucleonic thickness gauge and describing its use in various industries.—**Baldwin Instrument Co., Ltd.,** Brooklands Works, Dartford, Kent.

Loose-leaf catalogue pages dealing with pressure gauges of various types, vibration pick-ups and other gauges produced by the company, together with a leaflet describing the type M732 auto-developer for processing oscillograph records under daylight conditions. —**Southern Instruments, Ltd.,** Frimley Road, Camberley, Surrey.

LIGHTING FITTINGS.—Priced catalogue of domestic lighting fittings, etc., illustrated in colour.—**Osborn Manufacturing Co., Ltd.,** 5-13, Highgate Square, Birmingham, 12.

PRINTED CIRCUITS.—Pamphlet containing details of protective coatings for printed circuits and recommendations for dipped soldering techniques.—**Telegraph Condenser Co., Ltd.,** North Acton, London, W.3.

SWITCHGEAR. — Descriptive brochure dealing with the company's Class-J switchgear.—**A. Reyrolle & Co., Ltd.,** Hebburn, Co. Durham.

Descriptive brochure (LS 1200) of the company's "Oxted" range of fused distribution boards.—**Lancashire Dynamo Switchgear, Ltd.,** Hurst Green, Oxted, Surrey.

Illustrated brochure describing flameproof distribution switchboards produced by the company.—**Cantie Switches, Ltd.,** Port Causeway, New Ferry, Birkenhead, Cheshire.

WIRING ACCESSORIES.—40-page illustrated catalogue, together with separate price list, dealing with the company's range of wiring accessories.—**Ashley Accessories, Ltd.,** Ulverston, Lancs.

Catalogue, leaflets and a price list covering the company's range of wiring accessories, striplights and illuminated flower decorations, etc.—**Nettle Accessories, Ltd.,** Harper Road, Wythenshawe, Manchester, 22.

NEXT WEEK'S EVENTS

Monday, 28th May

IPSWICH.—Electric House, 6 p.m. Ipswich & District Electrical Association. Annual general meeting. (Revised date.)

LONDON.—Savoy Place, W.C.2, 6.30 p.m. I.E.E. London Graduates' & Students' Section. Annual general meeting, followed by film show.

Tuesday, 29th May

LONDON.—21, Bloomsbury Street, W.C.1, 2.30 p.m. Society of Relay Engineers. "Television Receivers for Rental Purposes," by F. Beaumont.

Manson House, 26, Portland Place, 6 p.m. Society of Instrument Technology. Annual general meeting, followed by "Process Analytical Instrumentation," by A. G. Stanley and J. F. Brown.

Wednesday, 30th May

GLASGOW.—39, Elmbank Crescent, 7.30 p.m. A.S.E.E. Glasgow Branch. Annual general meeting.

Wednesday, 30th May, to Saturday, 9th June

PARIS. — Conférence Internationale des Grands Réseaux Electriques (C.I.G.R.E.).

Thursday, 31st May

LONDON.—Connaught Rooms, W.C.2, 12.30 for 12.55 p.m. Batti-Wallahs' Society. Luncheon. Guest speaker, Admiral Sir Michael Denny.

Friday, 1st June

LIVERPOOL.—9, The Temple, 24, Dale Street, 6.30 p.m. A.S.E.E. Liverpool Branch. Annual general meeting.

Saturday, 2nd June

OXFORD.—Y.M.C.A., 10, George Street, 7 p.m. A.S.E.E. Oxford, Reading & Districts Branch. Annual general meeting.

PETERBOROUGH.—Institution of Production Engineers, North Midlands Region. Conference on "Aspects of Automation," at 10 a.m.

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 9th June:—

MONOTINA. No. 749,238. Class 9. Telephone apparatus and telephone instruments and parts.—Southern Instruments, Ltd., Frimley Road, Camberley, Surrey.

SOLENARC. No. 747,114. Class 9. Electrical apparatus and instruments and parts.—Etablissements Merlin & Gerin, Grenoble (Isere), France. Address for service, c/o Marks & Clerk, 57 & 58, Lincoln's Inn Fields, London, W.C.2.

ETERNA (design). No. B743,924. Class 11. Lighting installations, lighting appliances, heating apparatus, air-conditioning apparatus, refrigerators, cooking stoves, water heaters, and parts.— Ensel Electric Co., Ltd., 218-219, Upper Street, London, N.1.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—11th June. Melbourne City Council. 32 multi-contact relays. (E.S.B. 12533/56. Ten/19371.)*

22nd June. Mackay Harbour Board. Switchboards and starters for bulk sugar terminal. (E.S.B. 12583/56. Ten/19390.)*

25th June. Electricity Commission of New South Wales. Seven 10 MVA, 33/11 kV transformers. (E.S.B. 12512/56. Ten/19363.)*

28th June. Electricity Commission of Western Australia. Switchgear for Cannington switching station. (E.S.B. 12535/56. Ten/19381.)*

25th July. Electricity Commission of Queensland. Control panels, instruments and protective relays. (E.S.B. 12495/56. Ten/19358.)*

Belfast.—14th June. Borough Council. Electric travelling crane for Power Station West. (See this issue.)

Calne.—18th June. Borough Council. Street lighting equipment. (See this issue.)

Chichester.—8th June. West Sussex County Council. Street lighting equipment. (See this issue.)

Cornwall.—2nd June. County Council. Electrical installations in three schools. (See this issue.)

Eston.—4th June. U.D.C. Street lighting equipment. (See this issue.)

Formosa.—9th June. Central Trust of China, Purchasing Department. Electrical equipment including three 200 kVA transformers, cut-outs, cable, lightning arrestors, l.v. switchboards, heater lamps, etc. (E.S.B. 12463/56.I.C.A. Ten/19309.)* 12th June. Power supply equipment including 4,000 kVA substation, three 750 kVA outdoor power transformers and three 75 kV distribution transformers, 3·45 kV indoor switchgear and two sets of indoor switch cubicles. (E.S.B. 12720/56.I.C.A. Ten/19391.)*

India.—31st May. Bombay Electricity Board. V.i.r. w/p wires. (E.S.B. 12545/56. Ten/19353.)* 6th June. 22 kV transmission line, materials and equipment. (E.S.B. 12544/56. Ten/19339.)* 11th June. Two 1,000 kVA, 33/11 kV transformers. (E.S.B. 12546/56. Ten/19334.)* 14th June. Transmission line equipment, amendments to list. (E.S.B. 9356/56. Ten/18870A.)* 25th June. Power transformers for Southern Gujurat electric grid scheme. (E.S.B. 12547/56. Ten/19340.)*

31st May. Government of Bihar Electricity Department. 200 kW mercury arc rectifier set. (E.S.B. 12602/56. Ten/19411.)*

11th June. Hindustan Antibiotics, Ltd., Pimpri. 500 kW diesel generator sets. (E.S.B. 12571/56. Ten/19335.)*

20th June. Government of Andhra Electricity Department. Control and power cables. (E.S.B. 12427/56. Ten/19297.)*

31st July. Government of Bombay, Central Stores Purchase Organisation. Two 30,000 kVA synchronous condensers. (E.S.B. 12661/56. Ten/19380.)*

3rd July. India Store Department, London. Spares for wireless sets No. 62 and 1,000 Carrier's generating sets No. 12. (See this issue.)

New Zealand.—8th June. Auckland Electric Power Board. Weatherproof braided aerial cable. (E.S.B. 12359/56. Ten/19295 and E.S.B. 12358/56. Ten/19296.)*

3rd July. General Post Office. R.f. cables and 100 magnetic relays. (E.S.B. 12468/56. Ten/19332.)* 5th July. Six v.h.f./u.h.f. radio receivers. (E.S.B. 12180/56. Ten/19364.)*

Portuguese West Africa.—1st June. Angolan Military Command. 100 kVA transformer station and 10 kVA generating station. (E.S.B. 12558/56. Ten/19372.)*

Romford.—11th June. Electrical installations in shops and flats, White Hart Lane. (See this issue.)

South Africa.—7th June. Union Tender and Supplies Board. Electronic equipment, including condensers, ammeters, h.f. coils, Wheatstone bridges, etc. (E.S.B. 12212/56. Ten/19373.)* 14th June. Electric cable and wire. (E.S.B. 12216/56. Ten/19352.)*

15th June. City of Durban Electricity Department. Solid underground cable. (E.S.B. 12238/56. Ten/19336.)* 88 single-phase transformers ranging from 15 to 50 kVA. (E.S.B. 12239/56. Ten/19351.)*

27th July. Stores Department, South African Railways. Insulating enamel and varnishes. (E.S.B. 12556/56. Ten/19360.)*

Southend.—11th June. Rewiring of Richmond Avenue Junior School, Shoeburyness, and Wentworth High School. (See this issue.)

Syria.—6th June. Posts, Telegraphs and Telephones Administration. Six manual c.b. telephone exchanges. (E.S.B. 12228/56. Ten/19370.)*

United States.—8th June. Department of the Interior, Bonneville Power Administration, Oregon. Seventeen three-phase power transformers. (E.S.B. 12260/56. Ten/19424.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Barnes.—Four-storey block of flats and outbuildings at Little St. Leonards, Mortlake, London, S.W.14; W. R. Shepherd, borough engineer, Municipal Offices, Sheen Lane, London, S.W.14.

Barry.—Factory; Western Welding & Production Co., Ltd., Green Farm Road, Ely, Cardiff.

Basingstoke.—Junior and infants' schools at South Ham; Hants county architect, The Castle, Winchester.

Beccles.—Fire station at Ravensmere; Suffolk and Ipswich Fire Authority, Bond Street, Ipswich.

Belfast.—Factory, Ballymena, for Gallaher, Ltd.; Sir Alfred McAlpine & Sons, Ltd., builders, Hooton, Cheshire.

Bradford.—Modern detached villa for elderly men in the grounds of The Park (£28,250); W. H. Leathem, town clerk.

Brighton.—School and house at South Woodingdean; borough engineer and surveyor, 26-30, King's Road, Brighton, 1.

Factory on the Lower Bevendean light industrial site for West Instrument, Ltd.; town clerk, Town Hall, Brighton, 1.

Bristol.—Five-storey office block on the Small Street/Quay Street site, for the National Mutual Life Association of Australasia, Ltd., 5, Cheapside, London, E.C.2; Laurence M. Gotch & Partners, architects, 8, City Road, London, E.C.1.

Bromley.—Flats (28), at Weston Grove; Lionel Kaye, town clerk, Municipal Offices.

Carlisle.—Iron foundry, administration and amenities block, etc., on the Durranhill estate; White Bros., Ltd., Waterloo Foundry, Lancaster Street.

Chatteris.—Extensions to Cromwell School (£23,834); county architect, March, Cambs.

Chelmsford.—Factory off Brockley Road; Staniland Bros., Ltd., Beehive Lane.

Chesterfield.—Factory, Chatsworth Road; Plowright Bros., Ltd., Brampton Ironworks.

Chester-le-Street.—Houses (73), at Sacriston for the R.D.C.; F. Bowman, housing architect, Estate Office, Birtley.

Houses (160), at Lumley for the R.D.C.; Myton, Ltd., contractors, Hull.

Church Cowley (Oxon).—Infants' school (£42,350); county architect, County Hall, Oxford.

Croydon.—Norbury Manor Secondary School (£165,000), and adaptations to Overbury School (£112,900); E. Taberner, town clerk.

Darlington.—Conversion of the Arcade Cinema, Skinnergate, into ballroom for Circuits Management Association, 11, Belgrave Road, London, S.W.1.

Durham.—Modern school at Dunston Hill; Edwards & Partners, architects, 52, Eldon Place, Newcastle-on-Tyne.

Easington (Co. Durham).—Methodist church at Blackhall Rocks; J. W. Hays, architect, Central Chambers, Wingate, Co. Durham.

Edinburgh.—Extensions to Medical School buildings at George Square (£254,000), for University Authorities; W. N. Ramsay, architect, 529, Sauchiehall Street, Glasgow.

Exeter.—Houses (40), Rifford Road; city architect.

Felling-on-Tyne.—Houses and flats (136), Leam Lane; U.D.C. surveyor.

Goole.—Blocks of 120 flats in Alexandra Street; borough surveyor.

Gosport.—Congregational church (£27,000); Weston Burnett & Thorne, architects, 44, Westwood Road, Southampton.

Guildford.—Factory, Station Meadows estate; Durable Plastics, Ltd., Friary Square.

Halesowen.—Houses (105), Bassnage Farm estate; A. T. Butler & Partners, architects to T.C., 31, Priory Street, Dudley.

Harlow.—Works for Uni-Gun Lubricating Equipment, Ltd.; Y. J. Lovell & Son, Ltd., builders, Marsham Lane, Gerrards Cross.

Hebburn.—Second phase of Mid-Tyne Technical College, and ambulance depot in Victoria Road; G. R. Clayton, county architect, Court Lane Offices, Durham.

Hemsworth.—Houses (30), South Elmsall; S. Price, R.D.C. surveyor, Brierley Hall, Brierley, near Barnsley.

Hendon.—Houses (184), Claremont Road, and flats (32), Meadfield; A. O. Knight, borough surveyor, Town Hall, London, N.W.4.

Hexham.—Houses (100), to complete the Priestlands estate; W. A. Hancock, U.D.C. surveyor, Hexham House.

Jarrow.—Houses (108), at Calf Close Lane; borough engineer.

Leeds.—Houses (86); city architect, Priestley House, Quarry Hill, 9.

London.—Office block, Marylebone Road and Nottingham Place, St. Marylebone; John Laing & Son, Ltd., builders, Bunns Lane, N.W.7.

Dwellings (41), Forest Road, West Ham; borough engineer.

Special school, Rose Cottage site, Woolwich; Halse & Son, Ltd., builders, 5, Chapel Hill, S.E.18.

Maidstone.—Offices, workshops and showrooms, 62-64, King Street; Miles (Maidstone), Ltd., motor engineers, King Street.

Manchester.—Factory and offices, Pollard Street East, Ancoats; H. Gough & Sons, 4, Varley Street.

Matlock.—Electrical work on adaptation of Smedley's Hydro as Council Offices (£21,500); Works Department, Derbyshire County Council.

Middlesbrough.—Offices and showrooms in Borough Road/Marton Road; Crossley and Sons, Ltd., manufacturers and builders' merchants, Borough Road East.

Departmental stores, Corporation Road/Linthorpe Road; British Home Stores, Ltd., 129, Marylebone Road, London, N.W.1.

Morecambe.—Extensions and alterations to Balmoral Road School (£46,000); J. Siddle, builder, Cable Street, Lancaster.

Newcastle-on-Tyne.—Multi-storied garage, Vincent Street; P. L. Browne, Son & Harding, Pearl Buildings.

Factory, Rhodes Street, Sutherland & Co.; C. Solomon, St. Mary's Place.

North Shields.—Multi-storey Council flats (£139,062); Leslie & Co., Ltd., 80, Woodland Road, Darlington.

Northumberland. — New buildings at Thomas Taylor Homes for Northumberland C.C. (£63,000); county architect, County Hall, Newcastle-on-Tyne.

Nottingham.—House (126), Strelley Road; city housing architect.

Oxfordshire.—Secondary modern school, Charlbury, and primary school, Woodcote; county architect, Park End Street Offices, Oxford.

Peterborough.—Secondary modern school for girls, Eastholme estate; J. Cracknell, Ltd., builders, Huntley Grove.

Plymouth.—Workshop block for technical college; city architect.

Prudhoe-on-Tyne.—Council houses (221) at West Wylam (£326,000); J. M. Angus, 3, Gallowgate.

Saffron Walden.—New wing at Hatherley Hostel for the Aged, for Essex County Welfare Committee; H. Conolly, county architect, County Hall, Chelmsford.

Salford.—Flats (40), Lancaster Road area; city engineer, Town Hall, 3.

Sittingbourne & Milton.—Houses (38), on North Court estate, Contract No. 6; U.D.C. surveyor, Central Avenue, Sittingbourne.

Solihull.—Over 500 dwellings proposed as development of the Yardley Wood Road/Prince of Wales Lane/High Street site; C. R. Hutchinson, borough surveyor, 90, Station Road.

South Shields.—Three-storey shops and offices in the Market Place; John T. Bell & Sons, contractors, Market Street, Newcastle-on-Tyne.

Junior school, Chesterton Road; J. Smeds, architect, 56a, Camden Street, North Shields.

Secondary modern school, Harton Lane; Page, Son & Hill, architects, 75, King Street.

Factory, Simonside estate for Barbour & Sons; R. Collins, architect, St. Hilda Street.

Swindon.—Factory for the Metal Box Co., Ltd.; Wm. Townson & Sons, Ltd., builders, Park Hill Street, Bolton.

Torquay.—Coach station, Upton Valley (£20,000); P. W. Ladmore, borough surveyor, Town Hall.

Tynemouth.—Methodist church; H. D. Burton, Ltd., King Street, North Shields.

Wallsend.—Three-form school (£143,490); A. Anderson, Ltd., Stanmore Road, Newcastle.

R.C. infants' school, Churchhill Street; R. Burke, 10, Lambton Road, Newcastle.

Sixty three-storey flats at Willington West Farm and 24 flats at Low Willington Farm; G. N. Teasdale, borough engineer.

Wantage and Wallingford.—Houses (200); Pyle & Saint, architects, Thomas Street House, Cirencester.

West Hartlepool.—New St. James' Church on the Owton Manor estate; Cordingley & McIntyre, architects, The College, Durham.

Houses and flats (340), at Owton Manor; A. G. Sinclair, borough architect.

Weymouth.—Dwellings (79), The Lawns and Dorchester Road; borough surveyor.

Wolverhampton.—Houses (98), Willenhall Road North; borough engineer, Town Hall.

Wymondham.—Hostel block for Wymondham College; R. G. Carter, Ltd., builders, Drayton, Norwich.

York.—Extensions (£80,000) for Nunsthorpe Grammar School; Sorrell, Ltd., builders, Main Street, Heworth.

NEW PATENTS

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 30th May from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

21250. Chitty, J. A., and Armitage, R. F.—Electrically conductive elements or coatings. 28th August, 1951. (749621.)

1952

1877. Pye, Ltd.—Synchronising arrangement, particularly for television apparatus. 23rd January, 1953. (749573.) 3805. Waveform generator, particularly for television transmitting apparatus. 12th February, 1953. (749575.)

11418. British Thomson-Houston Co., Ltd.—Control systems for resistance welding apparatus. 5th May, 1953. (749815.)

18010. General Electric Co., Ltd., and Welch, E. E.—Methods of forming adherent layers of powdered material on supporting surfaces. 16th October, 1953. (749747.)

30143. Marconi's Wireless Telegraph Co., Ltd., and Buckingham, J.—Radar systems. 25th May, 1954. (749588.)

32848. Brennan, J. B.—Electric condensers and laminated sealing means therefor. 29th December, 1952. (749751.)

33118. Woods of Colchester, Ltd., and Daly, B. B.—Axial-flow fans. 22nd December, 1953. (749685.)

1953

98. Electric & Musical Industries, Ltd.—Colour television apparatus. 22nd December, 1953. (749511.)

434. Marconi's Wireless Telegraph Co., Ltd.—Colour television transmission. 6th January, 1954. (749590.)

2446 & 5401. Pye, Ltd.—Synchronising arrangement, particularly for television apparatus. 26th January, 1954, and 23rd January, 1953. (749592 and 749595.)

4188. Coler, M. A., and Louis, A. S.—Variable resistance device and method of moulding a resistance element for such a device. 14th February, 1953. (749626.)

4536. Standard Telephones & Cables, Ltd.—Electric gaseous-discharge waveguide switching device. 18th February, 1953. (749755.)

5584. Communications Patents, Ltd.—Television systems. 29th March, 1954. (749627.)

9374. British Thomson-Houston Co., Ltd.—Pulse generators. 5th April, 1954. (749628.)

10612. Autelca Akt.-Ges.—Teleprinters. 17th April, 1953. (749517.)

11124. General Electric Co.—Radiation detectors. 22nd April, 1953. (749687.)

11423. Parsons & Co., Ltd., C. A.—Infra-red analysing apparatus. 13th April, 1954. (749689.)

13744. Hoover, Ltd.—Washing machines. 6th May, 1954. (749764.)

14880. British Thomson-Houston Co., Ltd.—Navigational instruments. 28th May, 1954. (749600.)

14882. General Electric Co.—Phase shifting networks. 28th May, 1953. (749632.)

15049. Standard Telephones & Cables, Ltd.—Photo-conductive electrode. 29th May, 1953. (749601.)

16016. Landis & Gyr Akt.-Ges.—Counting mechanism for an electricity meter. 10th June, 1953. (749603.)

16241. Slutzky, N. J.—Adjustable standards or brackets for supporting electric lamps and other fittings. 6th May, 1954. (749771.)

16271. Telephone Manufacturing Co., Ltd.—Electric socket connectors and other electrical apparatus. 4th May, 1954. (749633.)

16642. Sutcliffe, Ltd., R., Hill, D. S., Johnson, I., and Metcalfe, P. N.—Protection equipment for electric motors. 30th March, 1955. (749522.)

17036. Standard Telephones & Cables, Ltd.—Hybrid circuits for connecting a four wire transmission line to a two wire transmission line. 19th June, 1953. (749694.)

17055. General Electric Co., Ltd., Savage, N., and Scrutop, A. H.—Apparatus for use in processes for coating tubes internally with a layer of finely divided solid material. 21st June, 1954. (749634.)

18082. Balint, A. T.—Electromagnetic device. 30th June, 1953. (749605.)

18490. National Research Development Corporation.—Electrical circuits using gaseous-discharge tubes. 5th July, 1954. (749773.)

18763. Electric & Musical Industries, Ltd.—Electrical signalling systems. 1st July, 1954. (749606.)

19054. English Electric Co., Ltd.—Electrical measuring instruments. 9th July, 1954. (749523.)

19264. Horvitz, G. J.—Carbon electrodes. 10th July, 1953. (749698.)

19693. Marconi's Wireless Telegraph Co., Ltd. — Television - kinematograph systems. 15th July, 1954. (749700.)

21138. Chloride Electrical Storage Co., Ltd.—Separators for use in lead-acid type electric accumulators. 15th July, 1954. (749778.)

22035. M-O Valve Co., Ltd., Baker, B. O., Wilkinson, K. H., and Wright, D. A.—Thermionic valves. 22nd July, 1954. (749611.)

23588. General Electric Co., Ltd., and Ferguson, H. M.—Light-directing members. 26th August, 1954. (749531.)

24501. British Insulated Callender's Cables, Ltd.—Joint for electrical conductors. 3rd September, 1954. (749649.)

25296. Licentia Patent-Verwaltungs Ges.—Dry rectifier element. 14th September, 1953. (749710.)

26841. Philips Electrical Industries, Ltd.—Time-lag electric relay circuits. 30th September, 1953. (749655.)

27130. Siemens-Schuckertwerke Akt.-Ges.—Dry rectifier arrangements. 2nd October, 1953. (749714.)

27690. Taylor, E. H.—Thermally controlled electric switches. 23rd September, 1954. (749716.)

28325. English Electric Co., Ltd.—Temperature responsive modulating valves. 8th October, 1954. (749540.)

28888. Cole, Ltd., E. K., Cox, V. J., and Reeves, R. J. D.—Automatic frequency control systems. 20th October, 1954. (749790.)

31408. Multicore Solders, Ltd.—Hand tools for stripping insulation from, or for cutting, insulated electric wires or the like. 16th September, 1954. (749793.)

33162. Allmanna Svenska Elektriska Aktiebolaget.—Static current convertor using voltage commutation. 30th November, 1953. (749726.)

33667. General Electric Co.—Electrical networks for effecting mathematical operations. 3rd December, 1953. (749556.)

36147. Hoover, Ltd.—Food mixers. 30th December, 1953. (749566.)

36212. Diamond H Switches, Ltd.—Electrical switches for low power circuits. 8th December, 1954. (749663.)

1954

120. Standard Telephones & Cables, Ltd.—Light amplifying device. 4th January, 1954. (749798.)

745. Heraeus Ges., W. C.—Apparatus for the generation and use of beams of electrically charged particles. 11th January, 1954. (749567.)

29050. Standard Telephones & Cables, Ltd.—Means for guiding a magnetic tape. 8th October, 1954. (749667.)

31570. Friemann & Wolf Ges.—Electrically operated safety lamp. 1st November, 1954. (749809.)

33603. Link Aviation, Inc.—Apparatus for testing multi-conductor cables. 19th November, 1954. (749669.)